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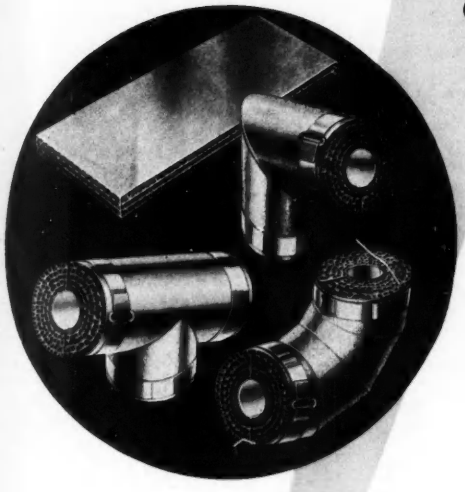

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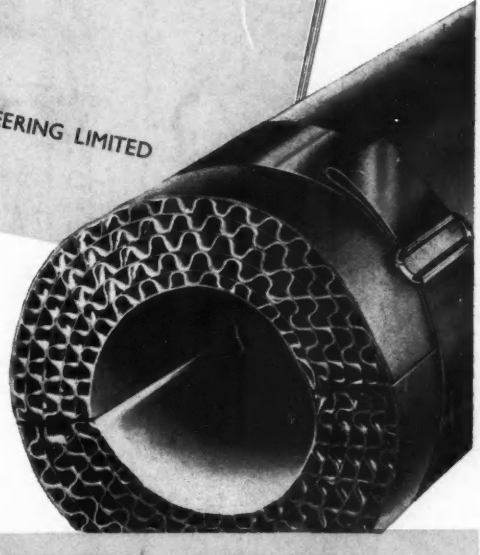

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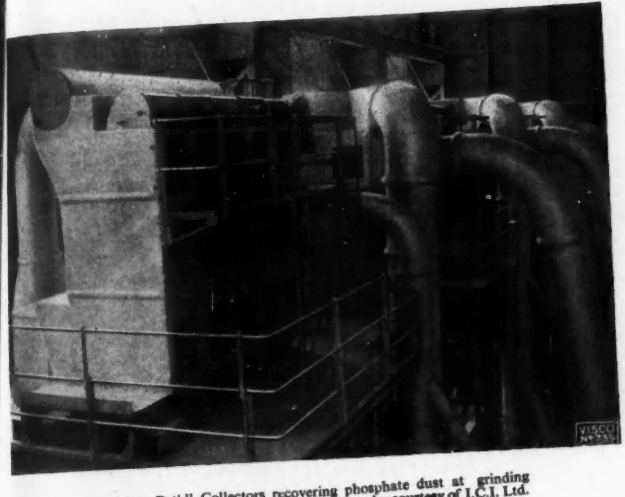

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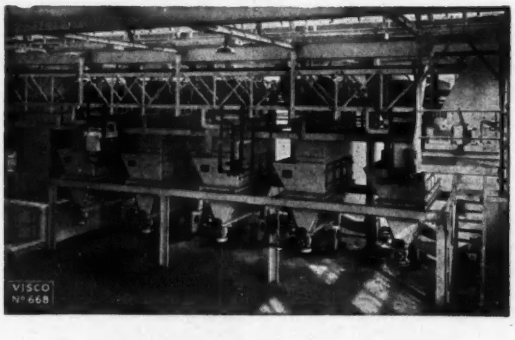

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THE ENGINEER

VOL. 204 No. 5303

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TAKE-OFF INTO SUSTAINED GROWTH

The American economist Rostow, whom Professor Blackett quoted in his Presidential Address to the British Association, printed on page 343 of our last issue, gives a particularly illustrative name to that period in a nation's history when it begins to industrialise itself. He calls it "the take-off into sustained growth." A nation, as Professor Blackett related, may exist for centuries maintaining for its people a low but stable standard of living, the small amount of saving possible being no more than sufficient to maintain a low level of capital development. Then, apparently quite suddenly, the situation alters. Industrialisation is begun, living standards rise, and an appreciable proportion of the increasing total national income is devoted to the expansion of the capital equipment of the country. Now (at 1949 prices) the peoples of underdeveloped countries have a real annual income per head of about £20—a figure which does not seem to have varied much for centuries—as compared with a corresponding figure of some £300 for the peoples of highly industrialised countries which achieved "take-off" about 150 years ago. Furthermore, the Western peoples save and invest productively some £30 per head, that is 50 per cent more than "pre-industrial" peoples have to cover both consumption goods and depreciation of existing assets. How does "take-off" come about? It will be significant to engineers that in this country, the first in the world to achieve the "take-off," the critical period relates to the last two decades of the eighteenth century. It was just at that period that the Watt engine was establishing itself. Whatever economists who are studying the "take-off" may conclude, therefore, it will be difficult for engineers to regard the correlation as a mere coincidence. In this country, at least, there can be little doubt that the "take-off into sustained growth" was triggered off by the coming of steam power. But there is one further point to be noticed. The steam engine was, in fact, invented by Newcomen some decades earlier. Why then was the "take-off" delayed? The answer must surely be that for all except special purposes, such as the drainage of mines, animal power or human muscle power was cheaper than steam power as developed by Newcomen engines. It was Watt's invention of the separate condenser, which, by immensely improving fuel economy, rendered it cheaper to generate power from fuel than to employ muscles for the same purpose. The point is a suggestive one. It suggests that the "take-off" in this country could not be achieved until wage rates were sufficiently high to make it economically cheaper to generate power from fuel than to employ muscle power. The same economic relationship between wage rates and mechanisation can be recognised operating throughout all the years which followed. High wage rates encourage mechanisation; mechanisation by swelling productivity increases living standards, thereby encouraging working people to demand still higher wage rates. Some such mechanism, no doubt, accounts for the "sustained growth" that follows upon "take-off." Yet the significance of Watt's steam engine should not be exaggerated. By his invention of the separate condenser Watt pulled the trigger to make Britain's economy "take-off." But the whole economy was quite clearly ready for the "take-off" at that time. So, as the event proved, were the economies of several European nations and of the United States. But, curiously, and for reasons that economists such as Rostow are now actively studying, many Eastern nations, nations which as Professor Blackett pointed out, had at earlier times been more advanced technologically than Europe, proved unready for take-off. In Britain, and in Europe generally, take-off occurred as a natural phenomenon. It was not planned; it happened. But for underdeveloped countries, particularly of S.E. Asia, the take-off must now, for some reason, be deliberately brought about. Presumably there is an economic cause; to judge by European experience it may be that before automatic sustained growth can ensue a certain minimum standard of living must be reached. Perhaps the underdeveloped nations have not reached it. In Europe the capital needed to start the process of sustained growth appears to have come from the diversion of the wealth, formerly applied to ostentation, of a numerous merchant class, to that purpose. No such class seems to exist in sufficient numbers in S.E. Asia or if it does it prefers to apply its wealth to the purchase of Western "luxuries," luxuries of a kind not available to our own ancestors. Thus, unless the West helps, the problem for underdeveloped countries amounts to this, that, ultimately to raise standards, they must first be lowered so that capital can be created. Nor is that the whole problem; for as Professor Blackett points out, only the rich Western nations have the capital to make full use of new scientific and technical discoveries so that even after "take-off" the gap in wealth will still continue to widen. "Decidedly, scientific and technical invention is no fairy wand to wave over a poor country to transform it into a rich one."

It is for these reasons and because he is wholly unconvinced about any innate mental superiority of the Western peoples

that Professor Blackett believes the West to have over-estimated the need of the have-not countries for technical advice and under-estimated the need for financial help. "The sending of experts to poor countries without the capital to carry out their plans could be as irritating as to send a trained cook to a family unable to pay the baker." He believes real help can be given only by making a loan or a gift of some £1000 million a year for a decade or two. Only by that means is there hope, he thinks, of closing the gap in wealth in a reasonable time. The point is debatable. For one amongst the nations, the U.S.S.R., is pulling itself up by its own boot-straps, and without external assistance, although it is being done by means of which the West cannot approve. Professor Blackett undoubtedly recommends substantial financial assistance on humanitarian grounds. But it may appeal to statesmen on political grounds. Without substantial financial assistance the nations of S.E. Asia may find themselves forced to adopt Communist methods. In this, as in many other fields, humanitarianism and wise politics may go hand in hand.

ECONOMY OR DEFENCE?

In their reports to Congress, United States defence chiefs have consistently emphasised that the ballistic missile will not seriously challenge the manned bomber until 1965. They base their view not only on the present relatively short range of the anti-aircraft guided missile, but still more on the immense difficulty in solving the problem of the re-entry of the ballistic rocket into the atmosphere. The nose of a missile which re-enters the atmosphere at a speed exceeding 10,000 miles an hour, tends to burn up and disintegrate. Moreover the American estimate of the probable accuracy of the intercontinental ballistic missile suggests that at present it is far from being "the ultimate weapon." Indeed, according to Dr. Doenberger, the designer of the V-2, about 25 per cent of those fired would land in the wrong country, let alone miss the target! No doubt for these reasons urgent priority has latterly been given to the production in the United States of the medium-range ballistic missiles—the Navy "Polaris," the Army "Jupiter" and the Air Force "Thor," all with ranges of up to 1500 miles—which present less difficulty and which could be launched from ships or oversea bases. It is thus not surprising that the Western World—particularly the United States—has been atonished and somewhat alarmed at the latest Soviet announcement. The Soviets claim in fact to have tested successfully a long-range intercontinental ballistic rocket which landed in the target area. (Presumably a 5000-mile missile reaching further than the Continent of Africa?) The rocket attained an altitude of 600 miles, struck the target at a speed of 15,000 miles an hour and had a danger space, or accuracy, of between 6 and 12 miles.

Hitherto there has been no reason to doubt Soviet claims of achievements in engineering and nuclear physics and it would be very unwise to discount this latest claim as mere propaganda. None the less, it seems strange that this vital information should be released gratuitously in view of the secrecy which the Russians maintain regarding their Armed Forces. In any event the announcement can have little effect on British defence policy. We know already from N.A.T.O. intelligence that the Soviets have a large supply of medium-range ballistic rockets—with a range estimated at 800 miles—missiles which would reach Britain if fired from Soviet occupied territory. But we do not know how many of the 35 cruisers, 150 destroyers and 700 submarines which we estimate the Soviet Navy will have by 1960 are to be powered by atomic energy and how many are to be armed with offensive guided missiles. Indeed, if, as the Government seem to believe, a war fought with nuclear weapons would come to an end in a very short time, it is impossible to understand the purpose of these large naval forces. Nor is it possible to comprehend our own Government's logic. They emphasise the importance of the Royal Navy's role in "bringing power rapidly to bear in peacetime emergencies and limited hostilities." Is it to be assumed that in giving shore support our ships need only anticipate another Port Said operation—an enemy lacking morale and modern aircraft and equipment? We should at least replace our four twenty-year-old cruisers and have carriers and cruisers equipped with modern anti-aircraft defence—with anti-aircraft guided missiles. In the event of global war, Government spokesmen repeatedly point out that the Royal Navy is one of a team and would be fighting alongside a large number of United States carriers, cruisers and destroyers. Yet as one of a team, Britain is apparently to spend her scanty resources in an attempt to improve on the American effort to produce a medium-range rocket—a rocket which must have a range of well over 2500 miles if it is to reach vital targets in the Soviet Union when fired from this country.

Perhaps the real answer is that the governing consideration in framing the current Defence White Paper was economy. Two years ago a replacement "for our rapidly ageing cruiser fleet" only awaited the tests of the guided missile "Sea Slug." Now, it seems, the "Sea Slug" is to be installed in the four fleet escort vessels. Even these much smaller ships—like the "Dreadnought" atomic powered submarine—will not be in commission for several years. Two were authorised in the 1955–56 and two in the 1956–57 Estimates, but the first has only now just been ordered. Again, our fighters—assuming we have the 1940 spirit and built up in a year or two an appreciable force armed with guided missiles with nuclear warheads—cannot, it appears, prevent "those dozen bombers getting through." Yet we can reduce the relatively small number we now have and still protect our retaliatory power despite the large number of R.A.F. and United States bomber bases in this country! Finally there is the actual wording of the Defence White Paper which might seem to many to have been deliberately drafted to give future Chancellors of Exchequer a loophole for economy. "The free world to-day," one paragraph reads, "is mainly dependent for its protection on the nuclear capacity of the United States. While Britain cannot by comparison make more than a 'modest' contribution, there is a wide measure of agreement that she must possess an 'appreciable' element of deterrent power of her own." Faced with more demands for the social services, is there any doubt that a Chancellor will bear in mind the first sentence and stretch to the uttermost limit the meaning of the words "modest" and "appreciable"?

The Engineer
100 Years Ago
(SEPTEMBER 11, 1857)

"FIRST IRON VESSEL MADE IN THE ISLE OF MAN"

"On Saturday, 5th instant, an iron screw auxiliary steamer, the Manxman, was launched from the shipbuilding-yard of Mr. James Patterson, in Ramsey Harbour. The vessel is 125 feet long, twenty-two feet across the beam, and twelve feet deep from deck to keel; it has been expressly built for the coasting trade, for which it is admirably adapted, being strong and substantial, laid down according to Lloyd's twelve years' specification. The hull is divided into three water-tight compartments; the one at the stern will contain the engine and boiler, and machinery for driving the screw propeller, which will be of 40-horse power. The Manxman is the first iron vessel which has been built upon the island. The shipyard at Ramsey has been in working operation for about two years, and has afforded profitable employment to the industrious youths and men of the neighbourhood, nearly 100 of whom are engaged. Three coasting schooners, varying from seventy to 100 tons, have already been built at these works. There is a patent slip made by Mr. J. Tickle, of Maryport, by which a vessel of 500 tons may be hauled up. Owing to the cheapness of labour and advantages of situation, the charges for the use of the patent slip are considerably below those at other ports."

"CALCUTTA LIGHTED WITH GAS"

"With rebellion, rapine, distrust and alarm on every hand, the career of improvement in India still remains unchecked. On the evening of the 6th instant, when the authorities of Calcutta had, or believed they had, occasion to inform the public through the newspapers that a British force at Cawnpore had been annihilated by mutineers and rebels, a part of that city was for the first time lighted with gas. The natives were, of course, greatly astonished and perplexed by this exhibition of the new light."

A Seven Day Journal

Anglo-American Aeronautical Conference

THE sixth Anglo-American Aeronautical Conference was held at Folkestone this week, attended by about 500 members of the Royal Aeronautical Society and the Institute of the Aeronautical Sciences. The opening paper, by Mr. M. O. McKinney, on V.T.O.L. and S.T.O.L. aeroplanes, showed that a scheme whereby the exhaust of a jet engine was deflected on to a slotted flap might have 75 per cent of the effectiveness of the jet flap as known in England : all schemes for jet or slipstream deflection, however, involved large pitching moments. The discussion exposed widely shared doubt as to whether vertical take-off could ever be economic. Dr. J. V. Dunworth discussed mobile nuclear power plants, pointing out that an aircraft might have to carry £1,000,000 worth of fuel, and that the use of reactors in aircraft was so ambitious that only a very cautious approach to the problem was being made at present. A description of the electric pilot-to-engine link for the "Proteus" engine, employing magnetic amplifiers for reliability, was given by Mr. G. M. Sturrock.

Fail-safe design of aircraft structures was the subject of Dr. A. E. Russell, who drew attention to the fact that to inject a single failure into a test structure was optimistic, since more than one crack might be propogated simultaneously in service. Mr. C. W. Harper described some N.A.C.A. experience with boundary layer control applied to increase the maximum lift coefficient of "Sabre" aircraft : the degree to which a decrease in landing speed was realised depended upon the control response and stall warning available to the pilot. Yesterday, the final paper was given by Squadron Leader T. C. Whiteside, on the subject of " The Human Pilot as an Aircraft Operator ": many of the shortcomings of the human being in the environment of an aircraft were examined, and it was shown that a pilot was likely to be inferior to a " black box " in motor tasks. But a human pilot was nevertheless justified, since a malfunction in a " black box " was liable to lead to purposeless activity whereas " man has determination."

Ceramic Tool Research

THE Production Engineering Research Association has undertaken on behalf of the Ministry of Supply, an investigation into six kinds of ceramic tool, and, for comparison, similar tests are being carried out on cemented carbide tools. The special equipment required for these investigations has been built, and we are informed that preliminary tests are also being made to establish the ranges of cutting conditions to be employed and to determine the wear characteristics of various ceramic materials. The performance of the tools will be determined over a range of cutting speeds and feeds when rough and finish machining alloy steel. Performance will be assessed on the basis of tool wear in roughing operations and of surface finish in the finish machining operations.

An examination will also be made of some economic aspects of the use of ceramic tools by carrying out tests in which the effects of various feed and speed combinations giving constant rates of metal removal will be explored. These tests will indicate the most suitable combinations of feed and speed for specified rates of production. The effects of cutting speeds of up to 1600ft per minute and feed rates of up to 0·030in per revolution will be investigated during the tests. The machining experiments will be carried out on a 17in swing high-speed lathe with a built-in running centre and a widely variable speed range. In the investigations particular attention is being given to the vibration characteristics on the machine tool and tooling generally in view of the particularly destructive effect vibration has on the performance of ceramic tools.

International Radio-Isotopes Conference

SIR JOHN COCKCROFT, Director of the Atomic Energy Research Establishment at Harwell, is presiding over the International Conference on Radio-Isotopes in Scientific Research, now being held in Paris. His opening address reviewed briefly both the history and the prospects of the new techniques. Although radio-isotopes must have existed in the early stages of the universe, began Sir John, most of them had long since been transformed into stable elements. Only with the discovery of artificial radioactivity, and with the production of these isotopes in particle accelerators and nuclear reactors, had they become freely available. " It is not often that a single tool or technique is the uniting factor to bring together scientists and specialists in such different fields," continued Sir John. " Radio-isotopes have achieved this because they have unique properties as research tools and are applicable to every branch of experimental science." The last ten years had seen a revolution in the biological sciences, a tremendous stimulus had been given to agriculture and animal husbandry, while industrial research and process control had benefited greatly. After congratulating U.N.E.S.C.O. for its work on the Conference, Sir John went on to say that, since the exchange of knowledge of radio-isotopes in research had never been restricted by secrecy, it was not surprising that international progress had been very fruitful indeed. During the last few years, and especially since the 1955 Conference at Geneva, many new laboratories had been established, even by smaller nations, and larger nations had made training facilities available to all. Sir John hoped that in this way the new ideas disclosed in the present Conference might soon be passed on to the engineer or industrialist for the general good. Such conferences would be needed as long as rapid progress continued to make new materials and techniques available. The building of new reactors with high neutron fluxes, and of other high-energy machines capable of producing new spallation products, would alone have justified the present conference. When these were supported by new methods of detection and new principles of use such as those now to be discussed, he felt the calling of regular meetings became imperative.

British Standards Institution

THE annual report of the British Standards Institution for the year ended March 31 last records the sale of more than 1,000,000 copies of specifications, and new issues bringing the total number of standards to over 3000. The report says that the number of subscribing members supporting the institution at the end of the year, rather more than 9000, is the highest reached so far.

The introduction to the report mentions achievements in both traditional and more recently established industries. There is, for example, reference to work on three new standards for colliery equipment and to the preparation of standards for automation and nuclear energy. There is also mention of the fact that, in order to promote the wider use of standards in industry, the Institution has contributed to new training courses concerned with standardisation, simplification and specialisation. Most of the report is inevitably taken up with a detailed review of the standards projects completed and in hand during last year for the sixty major industries served. Among them are standards for punched cards and paper tape ; safety standards for those engaged in industrial radiography ; standards for smoke indicators and smoke viewers, and, for coal mining, specifications for underground conveyor chains, steel arches and components for pit tubs.

National Coal Board's Summer School

THIS week the National Coal Board's eleventh annual summer school is being held at Oxford. The students, nearly 500 altogether, represent all sections of the industry, and the theme of the lectures and discussions is " The Colliery Management Team."

The opening address was given last Saturday by Sir James Bowman, chairman of the National Coal Board. In that address, Sir James said that a programme of mechanisation like the Coal Board's was not undertaken and carried out without difficult problems arising—technical problems demanding skill and resolution and human problems demanding adaptability and a willingness for fair dealing. Sir James went on to talk about the increasing use of power-loading machines, commenting, however, that the machines loaded coal and dirt alike and broke the coal up more. That, he said, was contributing to one of the Board's greatest current problems, which was the shortage of large coal. Last year, Sir James stated, the output of large coal dropped by about 3,500,000 tons, and despite the most vigorous efforts being made to halt the decline there would be a further fall this year. It was all the more serious, he added, when it was remembered that it was the shortage of large coal which compelled the country to continue the import of expensive foreign coal.

Later in his address, Sir James had a good deal to say about the coal mining industry's morale. He thought that the industry was in better shape than it had been for a long time, but, he remarked, its morale was not yet as high as it should be. Last year, he continued, there were 4400 separate disputes, far more than in any previous year since vesting date, and this year had seen no improvement. Absenteeism, Sir James commented, was another factor which had a direct and devastating effect on the industry's performance. It could destroy completely the fruits of the technical advances to which so much attention was being paid. In May of this year, overall absence at the pits was 11·85 per cent, compared with 12·25 per cent in the corresponding period of last year ; since then, however, absence had increased to 13·40 per cent, compared with 12·56 per cent last year ; it was equivalent to an increased loss of output of almost 2,000,000 tons a year.

Index to THE ENGINEER

THE Index to THE ENGINEER, Volume 203, January to June, 1957, is now ready and has been posted to all readers who have previously applied for copies. Any reader desirous of obtaining a copy who has not already applied, should write to The Manager, THE ENGINEER, 28, Essex Street, London, W.C.2 ; he will be sent a copy free of charge.

Obituary

Dr. R. W. BAILEY

The death occurred on Wednesday, September 4, of Dr. R. W. Bailey, who retired from active duties as consultant to the Metropolitan-Vickers Electrical Company's research department on March 31 this year.

After serving his apprenticeship at the Great Eastern Railway Company's Locomotive Works, Stratford, and taking an electrical engineering course at the City and Guilds Central Technical College, London, R. W. Bailey first joined Metropolitan-Vickers (then British Westinghouse) as a college apprentice in 1907. After his apprenticeship he forsook industry temporarily when he became a lecturer in mechanical engineering at the Battersea Polytechnic, London, and in 1912 he was appointed the first Principal of the Crewe Technical Institute (now Technical College). In 1919 he accepted an invitation to return to Metropolitan-Vickers, and took charge of the company's research department laboratory concerned with chemical, mechanical and metallurgical testing. He relinquished executive duties in 1945 to give more attention to special research and development work and to act as Consulting Research Engineer.

For his published work relating to the principles of design, behaviour and properties of metals at elevated temperatures, he earned the degree of D.Sc. (Eng.) of London University in 1936. He was also awarded the Thomas Hawksley Premium in 1929 and the Thomas Hawksley Gold Medal in 1935, by the Institution of Mechanical Engineers, of which he had been an Associate Member since 1922. He became a full member of the Institution in 1936, Chairman of the North Western branch in 1941, a member of the Council in 1942, a vice-president in 1949, and president in 1954. In 1949 he was elected a Fellow of the Royal Society, and he served on the Society's Council during 1951–52.

Mr. JAMES KENDALL

We regret to record the sudden death of Mr. James William Kendall at his home at Penn, Wolverhampton, on Saturday, August 24, at the age of forty-nine. Mr. Kendall received his early training at Woolwich Arsenal, and was subsequently with the site construction section of the Ministry of Works. Between 1940 and 1946 he was Assistant Director, Filling Factories, working under Sir Christopher Hinton, and in February, 1946, Mr. Kendall became one of the team of twelve that was then formed at Risley to build up the production side of the new nuclear energy programme. Only one of the members had any knowledge of nuclear energy, but the Industrial Group of the U.K. Atomic Energy Authority grew from their efforts. The tasks allotted to the team included the production of uranium metal, the design of reactors for the evolution of plutonium, and the planning of a diffusion plant for the separation of uranium isotopes.

Mr. Kendall was given charge of the design group which gained its first experience in building a large experimental pile named BEPO at Harwell. The group then designed and built the two reactors at Windscale, and these have been producing plutonium since the end of 1950. The fast breeder reactor at Dounreay was Mr. Kendall's next assignment, and he continued on this until April, 1956, when he left the U.K. Atomic Energy Authority to become head of nuclear engineering development for John Thompson, Ltd., at Wolverhampton.

Education and Training for the Engineering Industry*

By SIR DAVID ANDERSON

In his Presidential Address to Section G of the British Association, delivered last Friday, Sir David Anderson reviewed engineering education in this country. Though international comparisons show that Britain seems to be falling behind in the numbers of professional engineers it is training, Sir David was pessimistic about the prospects of increasing the numbers. He concluded his address by discussing the inclusion of management studies in engineering education and by making pleas for the fuller augmentation of apprenticeship training in this country and for more co-operation between educational establishments and industry.

The Importance of the Problem

Engineering is the most widespread and basic of our manufacturing industries. Not only is it a major industry in its own right, but practically every manufacturing industry depends on engineering for the design, operation and maintenance of its plant and equipment. Our whole industrial prosperity is therefore linked with our ability to organise and maintain a highly efficient engineering industry. Our need in this respect is clamant, since we are, economically, the most vulnerable industrial country in the world. Our massive imports of food and raw materials can only be paid for by an equally massive volume of exports. We want to export fine chemicals, not common salt ; scientific instruments, not steel billets ; electronic equipment, not copper wire ; precision machine tools, not steam-hammers ; the finest textiles, not cheap fabrics ; and so on. To establish and sustain this great volume of high-quality exports we must have an engineering industry first-class in every respect, and the basis for that is a sound system of education and training.

I am not going to spend time attempting to estimate the number of engineers and scientists required by the engineering industry. The figure is important but an estimate has already been made jointly by the Ministry of Labour and National Service and the Advisory Council on Scientific Policy, and the conclusion was that the number should be doubled in the next ten or fifteen years, that is, it should be about 20,000 per annum, and this was stated as "a minimum goal which needs to be achieved if the economy is to grow at an acceptable rate." Although the figure is a minimum, I think we must face the fact that it is not likely to be reached : the accelerating pace of economic and technical change is such that there is every indication of a shortage for many years to come. The diversity of activities and multiplicity of professions in our modern way of life are such that, at the higher levels of intelligence there is simply not enough manpower to go round. In industry the most urgent need to-day is not for more scientific discoveries but for a wider and more intensive application of discoveries already made. Every scientific discovery opens up a fan of potential applications, and the engineering industry will be able to absorb for a long time ahead all the recruits it is likely to get.

Although in this address I am concerned with education and training more than with potential numbers, it is interesting to glance in passing at what other countries are doing. Valid comparisons are difficult to draw, but from all the information available it seems that Russia, the United States, Western Germany, and Britain, are producing technologists, mostly engineers, in the ratio of 4 : 2 : 2 : 1 per unit of population. The conditions in Russia and the United States are very different from those in Britain, but with Western Germany we have much in common. The population of the two countries is the same, we are both at the same stage of industrial development, we are both heavily dependent on exports, and I find it more than a little disturbing that they are producing twice as many technologists as we are. This may be a highly significant factor when the European Market comes into operation.

At the lower levels of employment in the engineering industry there does not seem to be any manpower shortage. I think most firms can get an adequate number of apprentices and some can even exercise a considerable measure of choice. If this is so, recruitment to the middle cadre, the technicians, should also present no problem.

Relative Contributions of Technical Colleges and Universities

I have put technical colleges first because their contribution is numerically greater than that of the universities and because they make an important contribution at every level except that of the research scientist. Between the two world wars there was a remarkable development in the volume and standard of work in technical colleges. Post-war needs have accelerated this development and a new pattern for technical education is emerging in England.

Hitherto nearly all institutions have been treated alike in a common "technical college" group, but a certain difference of function is now being introduced. There is to be a small group of institutions called colleges of advanced technology, at the moment eight in number. As the name indicates, these colleges are to concentrate on advanced work, mainly, but not exclusively, in the form of full-time sandwich courses. Next there is to be a group called regional colleges. These will generally serve a wider area than that of a single education authority. They may offer sandwich courses as well as a large volume of advanced part-time work. Next there are to be area colleges and local colleges : these will be concerned with technical studies at a lower level, and work of a non-vocational character.

In the past the development of courses of graduate standard in technical colleges has been handicapped by the lack of an award commanding national recognition like a university degree. The new Diploma in Technology established by the National Council for Technological Awards under the chairmanship of Lord Hives removes this handicap and a rapid expansion in the volume of advanced work in the major technical colleges may be anticipated. The diploma is to be equivalent in standard to a university

* Address delivered at the Dublin Meeting of the British Association on Friday, September 6, 1957.

degree and already there is a demand that the Council should establish a higher award comparable with a Ph.D.

There have been developments, too, in the universities. They have all increased their accommodation for science and technology in accordance with Government policy and further expansion is being planned in selected centres.

With all these developments, both accomplished and planned, it is opportune to try to assess the relative contributions which technical colleges and universities are going to make in supplying the engineering industry with trained men.

The sub-professional group, comprising the skilled craftsmen, supervisors and technicians, whose education is provided for in part-time courses, will be dealt with by the appropriate technical colleges : the universities have clearly no interest in this field. In the professional group the research scientist will remain a university product, but the development engineers and designers, and the production engineers and managers, may be educated either in the universities or in the colleges of advanced technology or in some of the regional colleges. The university courses follow a uniform pattern of three years post-intermediate and lead to a degree. In the technical colleges there is some variety. The new sandwich courses leading to the Hives diploma will probably be of four, or perhaps five, years' duration. Some colleges now offer, and some will continue to offer, courses leading to the London external degree and these may be on a full-time or part-time basis. Lastly, there are the widespread part-time courses leading to a Higher National Certificate. Not all those obtaining a Higher National Certificate can be reckoned as of full professional status. The H.N.C. is a borderline qualification serving the lower ranks of the technologists group and the upper ranks of the technicians group. Probably about half those getting H.N.C.s will, with further study and experience, reach full professional status. With this general pattern in mind, it is interesting to examine the present output of engineers of graduate standard from the universities and the technical colleges as shown by Table I. A second table gives the output of scientists for comparison.

These figures are profoundly disturbing, particularly those for engineers. Our chief industrial competitors are well ahead of us now in their output of engineers and there is clearly no hope of closing the gap with numbers which are virtually stationary. Admittedly, the campaign urging the importance of technological education and the programme to improve its facilities have not been long under way, but, even so, too much should not be expected. The fact is that too many professions are chasing too few bodies, and other professions are conducting intensive recruiting campaigns. The chance of securing 20,000 graduates in science and engineering in the next ten years seems slender. There will undoubtedly be some increase in output both from the universities and the technical colleges, and I am fairly certain that the major increase is going to come from the technical colleges. These institutions are all linked with the great stream of part-time education, and it is in this stream that there is an appreciable reserve of good brain-power which could be picked out and transferred to full-time courses. It is doubtful if there is any appreciable reserve left in the grammar and secondary schools for direct recruitment at G.C.E. advanced level unless considerably more young people are going to show an interest in science.

Just after the war a question much debated was the relative roles which should be played in engineering education by the universities and the major technical colleges. Many held the view that the technical colleges should provide a more " practical " type of course, leaving the more theoretical approach to the universities. Like many other generalisations, this one was arrived at by feeling rather than by analysis. Actually, when one gets down to hard facts and draws up courses and syllabuses to provide the type of man industry wants, it is perfectly clear that in undergraduate courses of equal length the content and approach can differ very little whatever institution is offering it. It is a case of doubling up the supply rather than producing alternative types. The new pattern in technical education is in line with this view. The accommodation, equipment, staffing and conditions of service in the colleges of advanced technology are to be comparable with those in the universities and there is to be the same emphasis on research. The courses are to have the same content of basic science, and hence the man graduating after a five-year sandwich course will be pretty much the same type as the three-year university graduate after he has done a two-year postgraduate apprenticeship. There are now two routes to the same goal and a substantially larger number may well elect to take the sandwich course route. There is no reason why they should not do so ; the choice depends not on intellectual ability, but on personal taste and inclination. There will be many young men who will welcome the earlier entry into industry now that the end result can be the same.

The colleges of advanced technology will undoubtedly press for the early establishment by the Hives Council of a higher award. When that comes about nothing would be more stimulating than to see a considerable two-way movement of graduates between the colleges and the universities for postgraduate study and research.

I have spent some time on this new pattern of technical education, for it is a very important issue. The pattern is now set for at least the next twenty-five years and much is going to depend on the results. So far as the quality of education is concerned I have no doubts, but I am equally certain that the required output will not be obtained. Nothing must be left undone which would encourage young people to chose technology as a career, and in my opinion no single step would produce greater results than the conferment of degree-granting powers on some of our leading technological institutions. To draw again a comparison with our international competitors, we are the only industrial country in which the leading institutes of technology do not have full university status and in no other country is the output of engineers so small. I, personally, see a close connection between the two.

Management Studies in Engineering Education

To be efficient the engineering industry must have good management, because without good management the maximum return cannot be reaped from technological advance. Management studies should therefore have a place in engineering education. A common attitude to education for management is that " managers are born and not made." Fortunately, this attitude is changing. It stems, of course, from the fact that management is both a science and an art, a phrase often used without the relevance being made clear.

Broadly, a science is something which we " know," and is a body of fairly precise and verifiable knowledge ; an art is something which we " do " and knowledge in the scientific sense may play no great part. Every human activity is a mixture of science and art, but with wide variation in the relative proportions. Mathematics, the purest of the sciences, is largely a matter of " knowing." Chemistry, another pure science, is also a matter of " knowing," but with an art aspect in the experimental skill of the chemist. When we come to the applied sciences, such as engineering, the proportion of science and art, of " knowing " and " doing," has greatly changed. The main function of engineering is to make things, and, although there is much science in engineering, a great deal can be learned about the " doing " aspect from sheer practical experience. When we come to management we have taken another step towards the art end of science/art spectrum.

Now the further we move towards the art end of the science/art spectrum the more

Table I—*Output of Professional Engineers*

Note.—The figures for first degrees and diplomas are those given in the U.G.C. Returns under " technology " ; the great majority of these will be engineers. The London figures all relate to engineering. The Higher National Diplomas are in mechanical and electrical engineering and the Higher National Certificates are in mechanical, electrical, civil and production engineering. It has been assumed that 50 per cent of those getting H.N.C.s are of potential professional standard.

Qualification	Session					
	1950/51	1951/52	1952/53	1953/54	1954/55	1955/56
First degrees and diplomas (U.G.C. returns)	3175	3145	2999	3009	2760	2871
London, internal degrees from institutions with recognised teachers	242	268	231	209	219	233
London external degrees	570	456	469	309	250	237
Higher National Diplomas	245	203	264	239	251	310
Higher National Certificates, 50 per cent of output...	2598	2687	2769	2860	3041	3107
Total	6830	6759	6732	6626	6521	6758

Table II—*Output of Scientists*

Note.—The figures for first degrees and diplomas and the London figures are graduations listed under the Faculty of Science. The Higher National Certificates are in chemistry and physics. It has been assumed that 50 per cent of those getting H.N.C.s are of potential professional standard.

Qualification	Session					
	1950/51	1951/52	1952/53	1953/54	1954/55	1955/56
First degrees and diplomas (U.G.C. returns)	4474	4709	4660	4568	4564	4444
London, internal degrees from institutions with recognised teachers	338	329	276	210	194	178
London external degrees	965	1112	984	909	710	720
Higher National Certificates, 50 per cent of output in chemistry and physics	223	268	320	367	446	520
Total	6000	6418	6240	6054	5914	5862

difficult the subject becomes to teach, because skill in an art is more difficult to impart than knowledge of a science ; it needs practice, more than memory and understanding. It follows, then, that training for management must consist of two parts. First, the acquisition of certain factual knowledge in subjects like industrial history, economics, psychology, industrial relations, costing, work study, and so on, and, second, opportunities for practice in the art. This means a co-operative effort between teaching institutions and industry, and of all branches of study ; none requires closer co-operation. The materials which the engineer or metallurgist uses in the shops are the same as those he formerly used in the teaching laboratory, but the reactions of human nature on the shop floor have no counterpart in any classroom experience. If, therefore, we are going to raise the standard of management, industry must organise proper schemes of practical training.

There is a danger that industrialists will think too lightly of the efforts of academic institutions to teach management subjects, and will fail to reap benefits within their grasp. Industrialists know that teaching salaries are such that no college or university could ever compete with industry in the management field, but this is not so serious as it seems. A department of management studies is unlike any other department. Far less formal teaching is required and considerably more discussion. In science and technology the behaviour of things is predictable and can therefore be dealt with by the guidance of theory. Human reactions are unpredictable. There is infinite variety in human relations, no situation ever repeats itself exactly, hence practical experience can be a better guide than theory. One of the main functions of a department of management studies is to provide the surroundings and create the atmosphere in which intelligent discussion of experience can take place.

Management studies are commonly undertaken at the postgraduate stage, though they can have a considerable place in undergraduate courses of the type called in America " industrial engineering." I think the ideal arrangement at the postgraduate stage would be a planned series of short residential courses spaced throughout the earlier years of a man's professional life and I would emphasise the desirability of a series. In the hustle and bustle of industrial life there is just no time for reflective thought and unless opportunities are specifically provided, creative thinking about one's job goes by default.

Foremen and supervisors need such training as much as any other management group. I should like to see every man who was earmarked for promotion to foreman or supervisor being withdrawn from the shop floor and sent to a short residential course before taking up his higher appointment. Not only would this raise his status in the eyes of his fellow workers, but the training he received might make all the difference to his success in the new post.

Sub-Professional Groups

No survey of education and training for the engineering industry would be complete without reference to the sub-professional groups : supervisors, technicians, and skilled craftsmen. In these groups there does not appear to be any problem of shortage. Most engineering firms are able to recruit all the apprentices they need, and can frequently exercise a considerable measure of choice. Technicians may be recruited from senior apprentices or skilled craftsmen, or directly from school. Supervisors will generally be promoted from the ranks of the skilled craftsmen.

I think the time has come when British industry should make a serious examination of the apprenticeship system. A higher standard of technology needs to be backed up with better technicians and craftsmen. At the start of the century apprenticeship was much the same in Britain and in Continental countries, namely, a five-year period of practical training with some voluntary attendance at evening classes by a small minority. To-day British and Continental practice is widely divergent. West Germany has established apprenticeship on a national basis, with a rigorous system of training, examination, and certification. All apprentices are indentured, and the indentures are registered with the local Chamber of Industry and Commerce. Throughout the apprenticeship there is compulsory day attendance at a vocational school for six to eight hours per week. The duration of the apprenticeship is only three to three and a half years, and an apprentice must pass a written, oral, and practical examination before he can be certified as a skilled craftsman. The Chambers of Industry and Commerce are responsible for organising the examinations, in which the employers and trade unions co-operate.

The system applies to commerce as well as industry, and in Western Germany, there are nearly 600 occupations recognised as requiring a proper apprenticeship training. The problem of the small firm, unable itself to give a good all-round training, has been solved. Communal training establishments have been set up to give a basic training to apprentices from such firms. The work of these communal training establishments is highly regarded. There were about 3000 in operation before the war, and it is intended that the number should be increased. As an example of the scale on which apprentice training, examination, and certification is conducted it is interesting to know that in the City of Frankfurt, population about 600,000, the Chamber of Industry and Commerce in 1954 examined 4800 apprentices in 126 different trades. A full description of the German system is given in a booklet " Gaining Skill " produced by the Birmingham Productivity Association.

If we look at France we find the same problem being tackled in a different way. An apprenticeship can be served, not only in industry, but also in an apprentice training centre. These centres are part of the educational system not the industrial system, but employers and trade unions are closely concerned with their operation. There are nearly 1000 such centres catering for 160,000 apprentices—98,000 boys and 62,000 girls—and the courses last three years. With this arrangement the apprenticeship is completed before entering industry. About 40 per cent of the apprentices in France are trained in this way, the remaining 60 per cent serving a traditional apprenticeship. The apprentices trained in the special centres form a kind of *corps d'élite* from whose ranks are drawn foremen and supervisors.

In Switzerland the system is somewhat similar to the German system. There is compulsory part-time day attendance with a system of examination and certification. The duration of the training period is three to three-and-a-half years.

It is clear that apprenticeship training is now more thoroughly organised on the Continent than in this country. Far too many British firms give little attention to this problem and in the light of what is happening abroad it is disturbing to reflect that in Britain a youth can become a skilled craftsman without having attended a single class or passed a single examination in the whole five years of his apprenticeship. " Serving time " is the only compulsory requirement, and there is not the slightest doubt that in many cases this time is served in a very slipshod fashion. Without necessarily copying either the French of German systems, we should certainly address ourselves to improving our own.

The technician group, which falls below professional status, does not present any serious educational problems. The group is increasing both in size and importance because the tendency to-day is to bring everything under control and reduce to a minimum the personal choice of an operator as to how he will do a job. This means that after the design stage is finished there comes an intensive study of how the thing is to be made ; the choice of materials ; the choice of process ; the sequence of operations ; control and inspection at each operation ; provision and flow of materials to converge at the right place at the right time ; provision of special jigs and tools ; and so on. Further, at various points in the manufacturing process there will be scope for the application of a variety of automatic control devices many of which will be electronically operated.

Technicians are needed for this progress, planning, and automatic control work. These men do not need a thorough scientific training like the technologist. They need some basic science, a sound knowledge of industrial processes, some knowledge of instrumentation, and a certain expertise in applications. They can, at the moment, be adequately trained in part-time courses of the City and Guilds type. The upper limit of the technician group is not sharply defined. It merges gradually into the work of the professional engineer, and many technicians can attain professional status through additional part-time study. The standard of technicians' work is, of course, rising, and before long some kind of sandwich course may be needed to give a more rapid and intensive training.

Supervisors are generally drawn from the ranks of craftsmen or technicians. Their technical training will have been completed before they become supervisors, and what they need is some simple form of management training. As I have said elsewhere, the right approach is for these men to be withdrawn from their employment and given a short full-time course on the elements of industrial administration before taking up their supervisory posts.

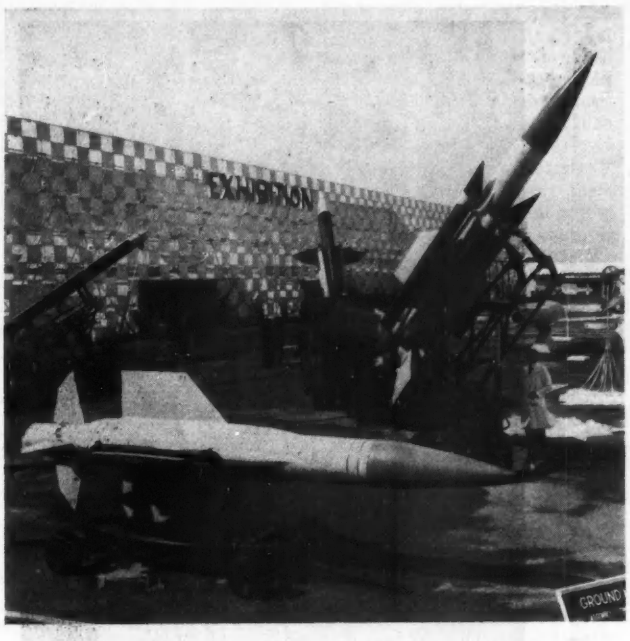
Co-operation Between Education and Industry

Co-operation between education and industry is much better than it used to be. Through conferences, discussions and visits, each has now a better understanding of the problems of the other. This is true both for universities and technical colleges, but there is still scope for improvement. In Britain we have nothing approaching the amount of staff interchange which takes place in America, where people move freely in both directions between industry and teaching. In this respect we are far more static and I think one reason is the lack of interchangeability in our superannuation schemes. University teachers are on one scheme, technical college teachers on another, and in industry each firm has its own. In these days when hardly anyone can save for retirement, the benefits of a superannuation scheme loom large and everyone thinks twice about making a move if he will thereby forgo some superannuation benefit. What we need is some kind of superannuation interchangeability which would permit movement without penalty between the universities, technical colleges and industry.

S.B.A.C. Display

No. II—(*Concluded from page* 353, *September* 6)

The eighteenth Flying Display and Exhibition of the Society of British Aircraft Constructors took place last week. There took part in the flying display transonic service aircraft and supersonic fighter prototypes, as well as the aircraft which captured the altitude record by use of a rocket engine. The exhibition included many examples of missiles and components for them; there are seen here the anti-aircraft weapon "Thunderbird," both bare and on its launcher, with the ram-jet "Bloodhound" in the background.

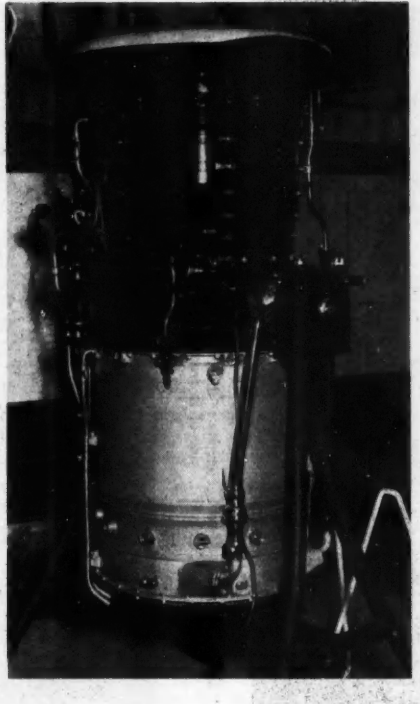


THE flying display at the Society of British Aircraft Constructors' eighteenth annual exhibition was described last week as it took place on Monday. On other days the English Electric P.1.B. interceptor took part in the display, and performed the high speed and high acceleration demonstrations given by the P.1.A. on Monday. The remarkable feature of this performance is that it is executed by Wing Commander R. P. Beamont unprotected by an anti-*g* suit; the claim that auto-stabilisation is used merely to allow the pilot to concentrate on an interception is clearly justified if a 360 deg. turn at 6 *g* can be executed low down flying manually. The makers of the aircraft have now made clear that the P.1.B. is regarded as equivalent to the earlier "Century Series" fighters of the United States, as distinct from such a machine as the Convair F.106.A. which will carry out an interception and kill largely automatically, with the pilot doing little more than get the machine airborne and supervise for failures.

Engines

There are illustrated on page 376 four new engines which appeared at the exhibition, three of which employ cycles still unconventional. The exception is a centrifugal gas turbine, built as a private venture by Armstrong Siddeley. This is a small engine, nominally 1000 s.h.p., and inspection of the compressor of, say, the Napier "Gazelle" confirms that for such powers the axial compressor demands many tiny parts and much exacting machining and inspection. The new engine, which in general arrangement recalls the "Gazelle," has a mass flow of 12·5 lb per second and uses two centrifugal compressors in series. There is an annular combustion chamber with vaporising burners, and a separate low-pressure turbine driving reduction gears at the exhaust end of the engine. The engine is claimed to afford long life and reliability rather than extreme efficiency, and the fuel consumption is 0·74 lb per shaft horsepower hour: the pressure ratio and turbine temperature are undisclosed. The engine comes in two forms, the P.181 to power helicopters, and the P.182 for prop-jet aeroplanes: in the latter case, the air intake plenum chamber would be at the rear end of the nacelle and the exhaust ducts would emerge behind the spinner. Both engines weigh 425 lb dry, are 30in in diameter and about 7ft long.

Also on display was the engine associated with the new world altitude record, the Napier "Double Scorpion." This runs on hydrogen peroxide and turbine fuel; hydrogen peroxide alone is decomposed to drive the pump turbine, which has the oxidant and fuel pumps in front of and behind it, respectively: the auxiliary catalyst chamber is fed from the peroxide pump and exhausts to atmosphere. While ceramic chambers are used on Napier missile motors, the "Scorpion" has regeneratively cooled chambers, the oxidant being fed into the casing near the rear of the nozzle. It is claimed that all short-lived parts, such as liners and catalyst packs, can be replaced in twenty minutes by Service tradesmen. The performance of the engine is undisclosed.

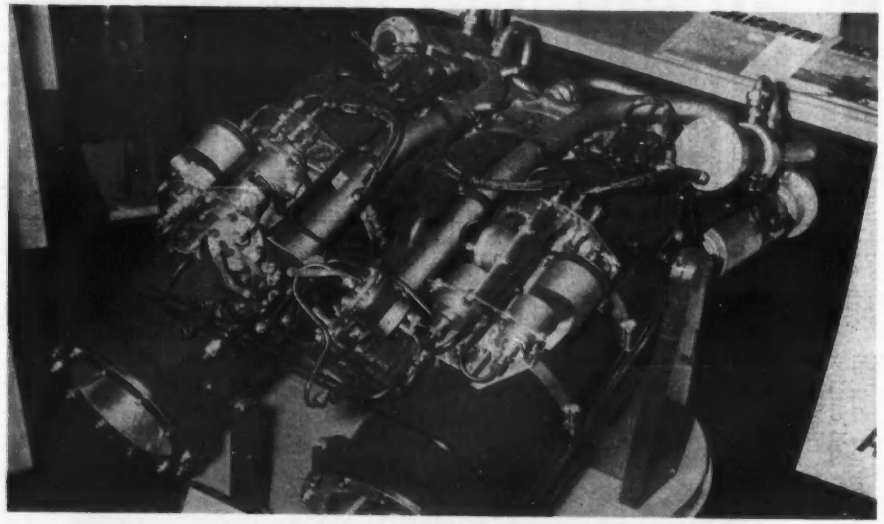


The Rolls-Royce "R.B. 108" lightweight jet engine for direct-lift vertical take-off

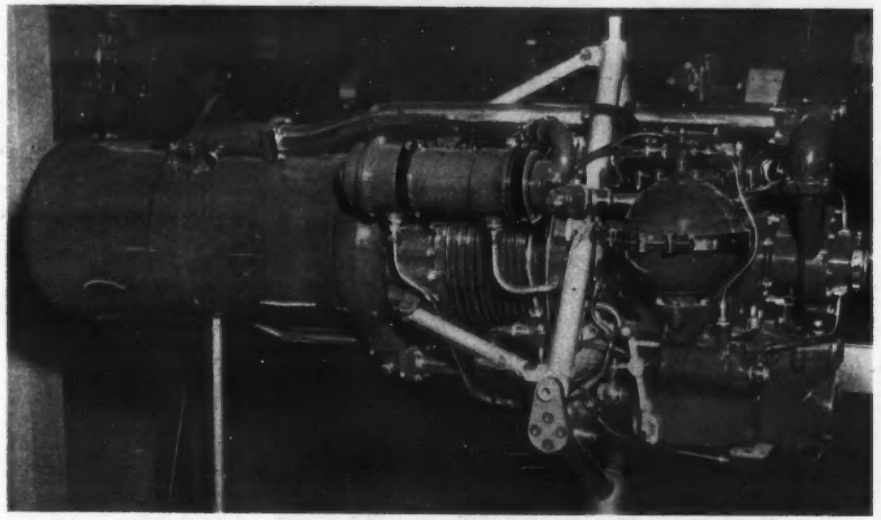
Another engine making its first appearance at Farnborough this year is the De Havilland "Spectre" rocket motor, which was flown in a "Canberra" test bed and in the Saro "S.R.53" mixed power plant interceptor prototype. This exploits to the full the relatively low temperatures associated with the use of the logistically convenient oxidant, hydrogen peroxide (burning turbine fuel, peroxide as an oxidant gives a chamber temperature of about 1300 deg. Cent., compared to 2000 deg. Cent. with nitric acid and 3000 deg. Cent. with oxygen). The engine is designed to run with a stoichiometric mixture, so that there is no risk of a malfunction causing overheating.

As would be expected of an engine whose manufacturers first departed from classical methods of heat release in the construction of auxiliary power units, the prime mover for the fuel and oxidant pumps is a turbine running on the relatively cool products of the decomposition of hydrogen peroxide (steam and oxygen at 600 deg. Cent.). However, to avoid any further sacrifice of specific impulse, the turbine exhaust is not dumped, but reheated in the combustion chamber. This implies, of course, that the auxiliary catalyst pack cannot be fed by the pumps which deliver the main supply of oxidant, and the information so far released states that there is a "separate supply" of hydrogen peroxide for the turbine. In the case of the "S.R.53," which is extensively provided with high-pressure nitrogen services, this supply might well come from a pressurised tank. Because of the high flow of the oxidant in this cycle—the fuel content is about 10 per cent—the oxidant is used for regenerative cooling of the combustion chamber walls. Otherwise, the engine generally resembles the earlier British rocket engine of steplessly variable thrust, the A.S. "Screamer" (the oxidant in that engine was liquid oxygen, which was unsuitable for contact with hot metal). In particular, it avoids the problem of having to reduce the throughput of one chamber of a multi-barrelled engine as another is lit up by using one chamber only; it is probable that the control problem at low thrusts, where a large chamber is most likely to be unstable, is eased by conferring upon

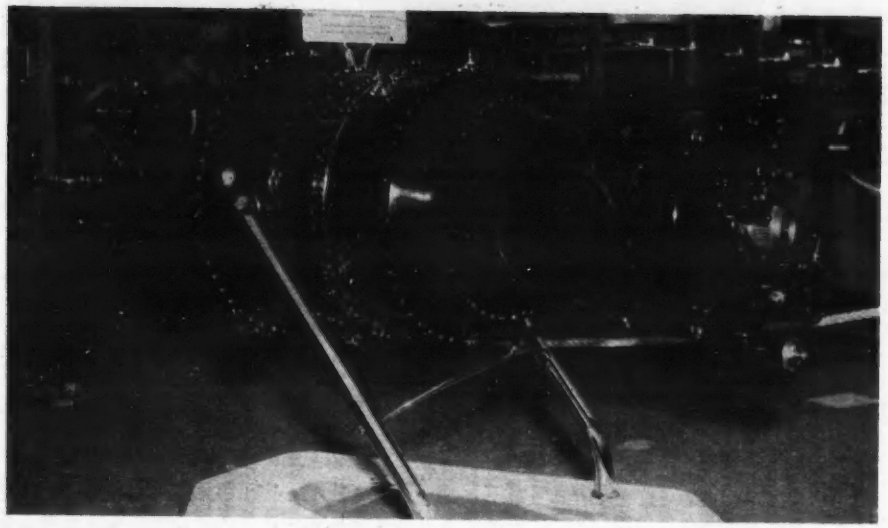
ENGINES AT THE S.B.A.C. EXHIBITION



The "Double Scorpion" rocket engine: the curved duct in the centre is the turbine exhaust, and on each side of it are the oxidant delivery pipes

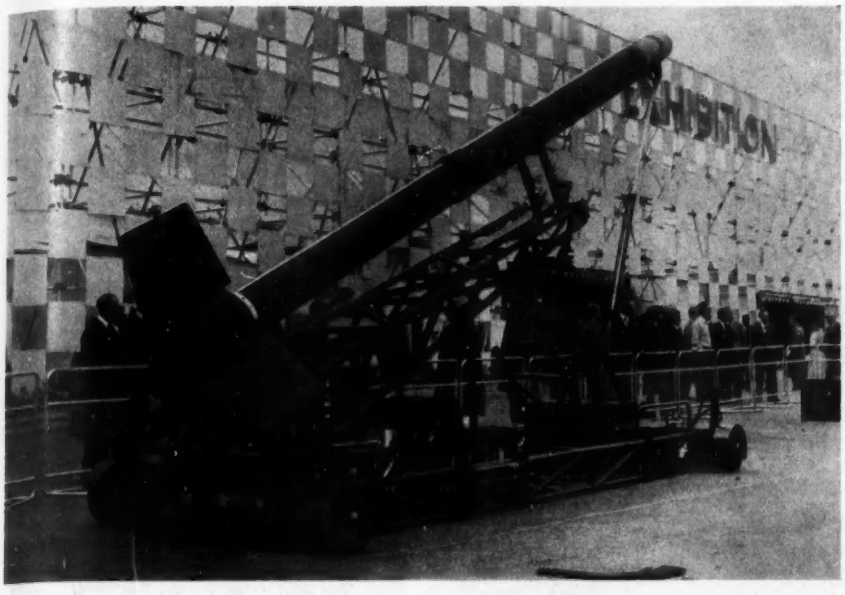


The "Spectre" single-chamber rocket engine: the catalyst chamber is the ribbed cylinder, and the fuel feed to the combustion chamber can be seen below it



The Armstrong Siddeley "P.181" free-turbine engine is intended for helicopter applications. The exhaust can be seen next to the reduction casing on this model

The Bristol "BRJ 801" ram-jet is bigger and more elaborate than the "Thor" seen below it, and may be a self-contained power unit



The Bristol "Borzoi" consists of a booster motor provided with stabilising fins and, in the extreme nose, equipment to telemeter observations to the ground

the pilot the ability to run the engine "cold," i.e. without combustion of kerosene. The fact that the engine will so run is utilised in the quest for safety by starting and stopping as a mono-propellant motor, thus ensuring that there is no kerosene in the combustion chamber.

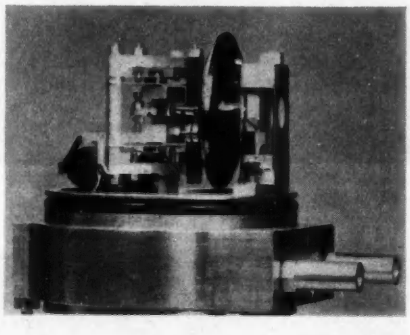
The remaining engine is a new Bristol ram-jet, apparently 18in in diameter against the 16in of the "Thor." As can be seen, it is basically similar in construction, although the nose cone covers inevitable at exhibitions allow no comparison of their design speeds. However, it is noticeably more complicated, and there is a ring of air outlet slots near the flameholder. Thus, it may be inferred that instead of containing merely a fuel control unit in its centre body and being dependent on the vehicle proper for a supply of fuel under pressure, like the "Thor," the "BRJ 801" has taken the logical step forward of using the main engine diffuser as its source of compressed air, and has a fuel pump in the centre body. This clearly would render the air flow and fuel flow parts heavily interdependent, and might present interesting problems to the control gear.

Also under this heading there might be considered the Bristol "Borzoi," a test vehicle for a boost rocket with an I.C.I. propellant. This booster is required to give 45,100 lb thrust for 5·1 seconds, and the enormous surface required to be exposed to the reaction leads to a very, very slender configuration. (It is illustrated on this page.) The nose of the rocket carries telemetry equipment—it can easily be imagined that the acceleration of this vehicle towards all-burnt might defy observation from the ground—and when on the launcher is energised by cables running along a light extensible boom, which is withdrawn before firing. The launcher is also used as a transporter for the vehicle, hydraulic jacks being provided to transfer the weight to the wheels.

Illustrated on page 375 is the Rolls-Royce "R.B.108." This is a light-weight engine to provide jet lift for vertical take-off or landing; fuel consumption is unimportant, and in principle long life is also secondary, although reliability would be highly critical if, as is at present expected, the favourable power-weight ratio of the smaller engine leads to the employment of unprecedented numbers of engines—one project emanating from Rolls-Royce has fifty-six lift engines. The Short "S.C.1" research aircraft has flown with a single "R.B.108" installed at the tail in the conventional attitude, and has now had the remaining four engines installed vertically amidships.

Equipment Exhibited

The central air data system displayed by Elliott Brothers (London), Ltd., follows the trend established by the use of a single source of heading information and a single attitude sensor by providing a single reference for ambient pressure and other aerodynamic information. While the device itself is duplicated because of its vital character, it displaces perhaps a dozen individual generators of air speed, Mach number or other signals for the human crew or automatic services.



Pressure transducer of the air data computer: the temperature compensated capsule support can be seen and, at the far end, the armature of the a.c. pick-off moving in front of the coils

The installed weight of the system might be 60 lb and the power consumption 60W.

Near to the pitot-static head is located the transducer, part of which is seen above. There is an evacuated capsule to measure static pressure and a second capsule connected to the pitot tube to measure pitot-static pressure; in each case movement of the capsule is magnified mechanically to move an armature across the poles of a pair of cored coils, and the resulting difference in their impedance is cancelled by a motor moving the coils. This a.c. pick-off runs on the aircraft 400 c/s supply, and potentiometers driven by the motors generate output signals. The mechanical linkage is both statically and dynamically balanced, and because the effort to move it is low, hysteresis becomes unimportant; sensitivity is such that a change in height of 1ft at sea level can be detected. This low hysteresis is obtained with bellows of a relatively thick material, giving small total deflections; it is temperature compensated in the example illustrated by a bi-metal rod distorting the panting plates on which the bellows is carried, but a further development will be to maintain the entire transducer at a steady temperature by electric heating. There is also provided a thermocouple detecting stagnation temperature, monitored by an a.c. bridge.

The computer handling the outputs of S (static pressure), $P-S$ (dynamic head), and T_s (stagnation temperature) is partly mechanical and partly electrical in its functioning. A linear function of static pressure is used to drive a tape before a window facing the pilot, and the tape is calibrated in terms of altitude, using the 1951 model atmosphere of Wright Air Development Centre. The speed, as distinct from the attitude, of the motor moving the static pressure pick-off provides rate of change of pressure, and a cam set according to static pressure allows this to be translated into rate of change of height. Indicated airspeed is obtained in a manner analogous to altitude, being a square root function of $P-S$.

Mach number signals are derived from the ratio $P-S/S$, which, below Mach 1, is given by

$$\left(1+\frac{\gamma-1}{2}M^2\right)^{\frac{\gamma}{\gamma-1}}-1,$$

and above Mach 1 by an expression of some complexity, which, for $\gamma=1\cdot4$, can be written

$$\frac{166\cdot92M^7}{(7M^2-1)^{2\cdot5}}-1.$$

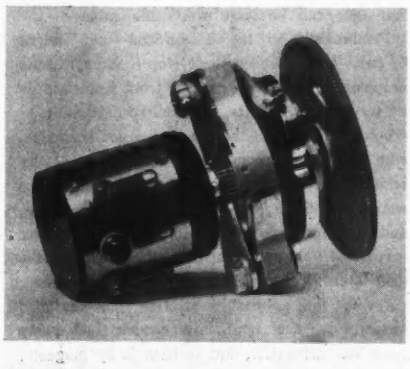
These relations are treated by driving potentiometers with a logarithmic characteristic off the static and pitot-static pick-offs, and subtracting the outputs, obtaining a signal proportional to

$$\log(P-S)-\log S.$$

A cam incorporating the antilogarithm of the relations given above drives the Mach-meter. True airspeed is derived from the expression

$$V=38\cdot94M\sqrt{T_s},$$

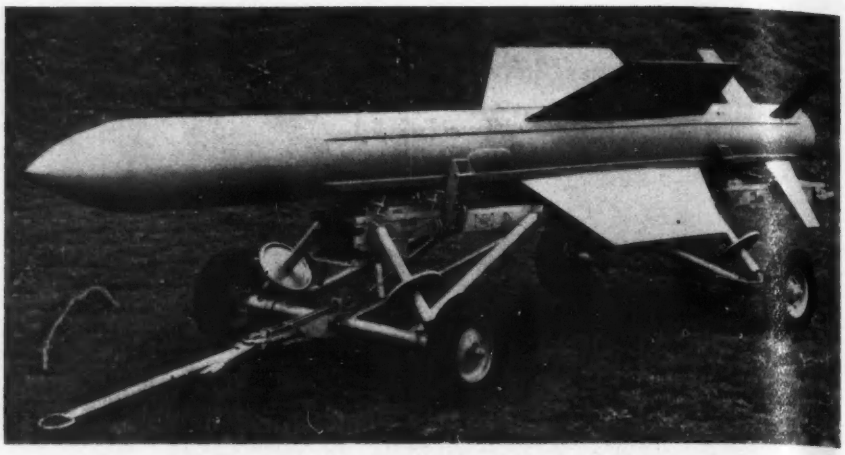
again using logarithmic potentiometers to generate electrical signals and an anti-logarithmic cam to present the solution in



Differential generating non-linear relationship. The zero-backlash gear drives the cage and the stationary cam modifies the output to the synchro

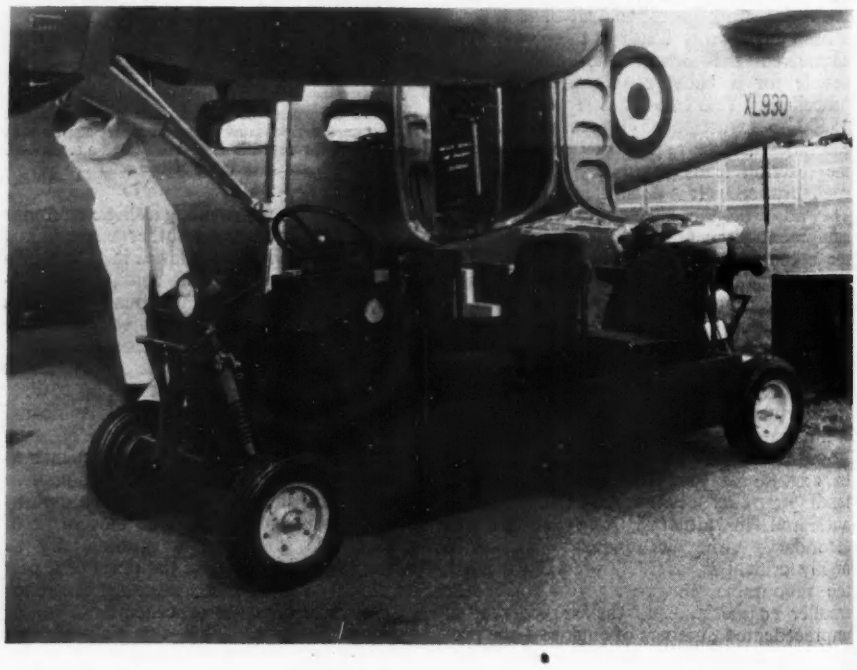
Military Stores at the S.B.A.C.

The adjoining picture shows the very large airborne missile displayed by Vickers-Armstrongs and referred to as the "888": photographs showed it being launched from under the wing of a "Canberra." There is some similarity to the other British airborne missile with a sustainer motor, the "Firestreak," particularly in the sharp radius of the fuselage rear or boat-tail. In contrast, the aerofoils are tapered in plan on all edges, and have a high aspect ratio in the case of the controls, and the nose is a short ogive.



The illustration on the left gives additional details of the Vickers-Armstrongs "891" anti-tank weapon, described on page 353 *(ante)*. In the foreground the control apparatus, consisting of a binocular viewer on a tripod, can be seen: the right thumb of the dummy soldier is adjacent to a control lever. The controller is connected by a single cable to the launcher, and can be quickly transferred from an expended one to another. Displayed beyond the controller is the actual missile: notable are the low aspect ratio aerofoils, which reduce the risk of striking trees or other objects. The control surfaces are hinged to the trailing edge of the wings, and are very large, which must demand very fine control response. The vehicle will undoubtedly be stabilised against roll and probably has only simple control responses, possibly of the "left-centre-right" order. There appears to be a contact fuse in the nose, and certainly a missile of this size would be unlikely to damage an armoured vehicle except by a direct hit

Very great savings in air transport are expected to result from the use of the Hunting "Harrier," seen on the right, instead of ¼-ton trucks as personnel carriers for airborne troops. In addition, the vehicle is so cheap that it may pay to abandon it rather than air-lift it back to base. When folded, each "Harrier" occupies little more than 33 cubic feet—one can be seen within the cabin of the "Pembroke" in the background—and weighs 6¼ cwt. It is intended to develop it for parachute dropping. As can be seen, the front suspension is by very long wishbones, with coil springs and telescopic dampers, and the rear suspension is similar, with the wheels coupled by simple universally jointed shafts, there being no differential. The engine is a 650 c.c. B.S.A. four stroke vertical twin, and the motor-cycle positive-stop four-speed gearbox is retained: the hand control for the clutch is on the gear lever. The vertical member at the front end, carrying the adjustable steering column, also supports the fuel tank. An electric fuel pump feeds the carburetter, but ignition is by magneto.



shaft angle. The computer also includes automatic correction for the position error of the pitot head and for the sea-level barometer reading, set in manually. The method of generating non-linear relationships in the mechanical sense is not without interest; a linear relation is fed across a differential, and the "planets" of the differential feed in the departure from linearity as dictated by a cam. Such a device is illustrated on page 337; a second sector and cam follower is provided on the opposite side of the differential to maintain balance.

This flexible tank is provided with rubber bollard locating studs: the tank below it, also flexible, has metal fasteners standing a 160 lb pull

The information is presented on instruments having the appearance of edge type dials. Where they are, in fact, moving tapes, some system to allow the indication to be comprehended at a glance without study of the figures is required, and in the case of altitude this is obtained by using a two-coloured tape with the band of lighter colour wider at the high altitude end. Similarly, flight limitations can appear on the speed and Mach number tapes. The vertical speed indicator is adjacent to the altimeter, and since the zero is opposite the reference point of the altitude tape, by keeping the rate-of-climb needle in line with a height indication on the altimeter, the aircraft is caused to level out at that height. There is at present no provision to present commands to the pilot on the same instruments.

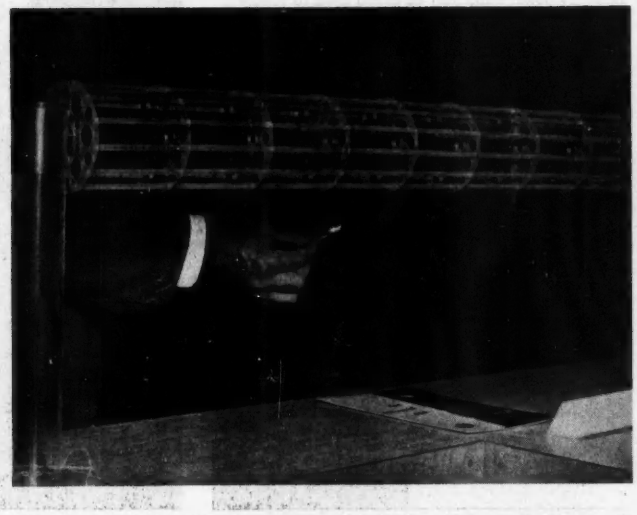
Fuel tanks which are sufficiently flexible to be passed through a relatively small access door allow a significant improvement in the efficiency of the supporting structure, while still avoiding the need for a thoroughly fuel-tight structure for use as an integral tank. A new material for such tanks, "Marlite," was shown by Marston Excelsior, Ltd.; it is 0·018in-0·020in thick, weighing 1·4 oz per square foot, and has effected savings in weight of 250 lb per aircraft over 0·030in "Flexelite." The material is essentially a two-ply nylon and "Terylene" fabric construction with a special fuel-resistant resin barrier held as a sandwich between the fabrics. The material has a minimum specific strength of 9000 lb per square inch and is completely ozone resistant. It is suitable for use with all hydrocarbon fuels and also with methanol/water. The bag is quite stable, there being no attack or leaching action by fuels. The permeability is claimed to be one-hundredth of that with normal rubber-like tank materials.

The material and method of manufacture make it possible to produce tanks very accurately to the desired shapes. However, tolerances on manufacturing tools both for the tanks and for the compartments in which they are fitted permit discrepancies which cause a tank to appear slightly undersize or oversize when installed.

With this in mind, tests have been performed on "Marlite" tanks made deliberately oversize and undersize. In the case of the oversize tanks a 1ft cube was placed in a container of the same size, but in addition a piece of wood ¾in by 1¾in was placed centrally down the whole of one vertical face of the container; this caused very severe creasing. The tank was slosh tested with fuel at 50 deg. Cent. for 3600 hours without failure occurring; the tank was removed and pressure tested at 500-hour intervals throughout the test.

To check the effect of a tank being undersize, or bridging portions of the structure, a 1ft cube tank was placed in an oven at a temperature of 40 deg. Cent.; the tank was not supported and the fuel inside was subjected to 1 lb per square inch additional pressure. After fourteen days and nights continuously, no detrimental effects could be traced when the tank was checked for leakage and for evidence of damage.

Various fasteners can be used to locate the bag, including rubber bollards and a quick-action metal fitting which will stand a 160 lb direct pull. These "Morcro" fasteners can be seen in the illustration on this page; they are opened or shut by reaching into the bag and moving the inner end of the central core out or in. Special reinforcement bonded to the tank during manufacture can be clamped to the structure by studded fittings. An example of a tank for a Vickers "Viscount" was displayed.



The detection of flame by the presence of ionisation is demonstrated by this rig: the cage is merely to protect the element, which is a wooden dowel

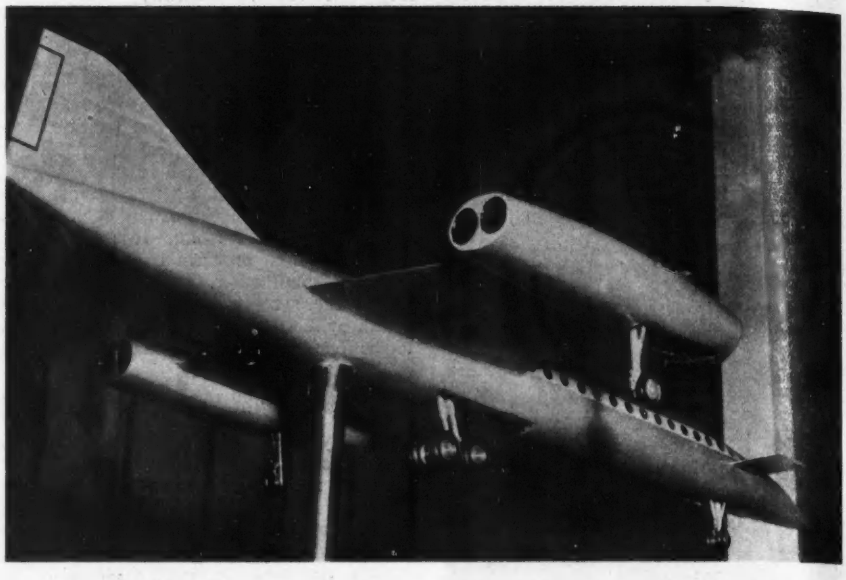
On the stand of Graviner Manufacturing Company, Ltd., there was demonstrated a newly-developed technique of fire detection based upon the existence of ionised gases in flame. The sensing element consists of a semi-conductor held at a high potential, in this example 30kV; the supply is through a very high resistance, so that the element can be handled without danger. The presence of a flame within the electrostatic field around the element will result in negative charges being attracted to it, with the effect that a current passes through the potential generator; this current is therefore a signal of fire. The high voltage is developed by a single valve oscillator and a voltage doubler rectifier circuit; the current monitor is on the low potential side of it, and uses a cold cathode trigger valve as a detector, being sensitive to a current of the order of 1μA. The demonstration unit, which had a wooden element, was used to show the inherent self-cleaning action of the device, dust or ash scattered upon it being flung off immediately. Any large object earthing it will, of course, produce an alarm signal. While experimental units have performed satisfactorily in simulated aircraft fires, it is expected that initial applications will be in cases where temperature sensing is inadequate because extreme speed of response is required; this device could be used where a photo-electric sensor was ruled out because darkness did not prevail. Our illustration shows the detector responding to a lighted match; a cigarette would also be sufficient to trigger it at this distance.

A noteworthy trend in this year's exhibits is towards pneumatic ancillaries running at low pressures such as can be derived from the main engine compressors. While this practice shows clear advantages only for heavy loads required transiently, as for engine starting, since the inefficiency of transmission over long distances counteracts the weight advantages, it is to be expected that it will become more general as aircraft performances increase; the cooling of electrical insulation and the sealing of hydraulic systems is already dictating the limits of their applicability. The exhibits of the Plessey Company, Ltd., included both large and small air motor-driven actuators: a ram able to run at 300 deg. Cent. was shown; delivering a thrust of 5000 lb over a 5in stroke in one second, it consumes 0·7 lb per second of air at 120 lb per square inch. The actuator has a recirculating ball nut to produce the linear motion, and shock absorbing devices at each end of the stroke, but weighs only 33 lb. A rotary actuator for the same air mass flow but able to accept air up to 400 deg. Cent., and an ambient temperature of 250 deg. Cent., offered 50 lb-ft torque for 20·5 revolutions. An instance in which the convenience of pneumatic drive was more prominent than its lightness was a ventilation or cooling blower shown by Plannair, Ltd. This has a single stage 6in diameter axial impeller, and the turbine blades are arranged around the periphery of the rotor. Control of the fan speed through a wide range is simply effected by restricting the flow to the nozzles.

Erratum

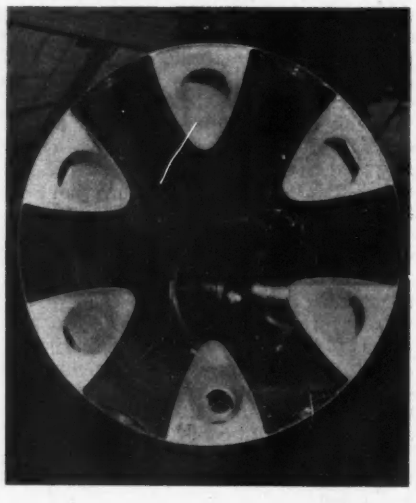
The high aspect ratio development of the Miles "Aerovan," which was reported flying and illustrated in last week's article, was the H.D.M.105 of Hurel-Dubois and Miles (Aviation), Ltd. The name "Caravan" belongs to the H.D.M.106, which is at present in the design stage.

Technical Exhibits at the S.B.A.C.

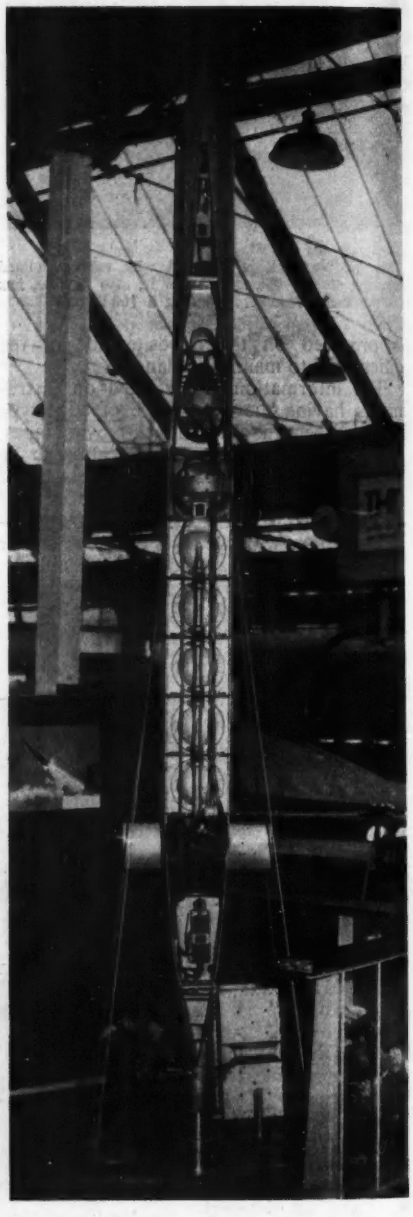


Shown in model form by Electro-Hydraulics, Ltd., was a quadricycle undercarriage. This is fundamentally different from undercarriages such as that of the "Stratojet" bomber in that the nose wheels may be only lightly loaded, so that landing attitude is not critical and high drag exists at touchdown, and in that the outer sets of wheels are intended to carry perhaps 20 to 50 per cent of the total weight. These outer wheels not only improve the stressing conditions and counter excessive bank on landing, but also, by use of differential braking, allow a high degree of control in taxying. It is not considered essential to install the three main undercarriages in the same transverse plane. The model, seen in the top illustration, shows how the quadricycle might be applied in a supersonic aircraft with a thin wing and widely distributed masses.

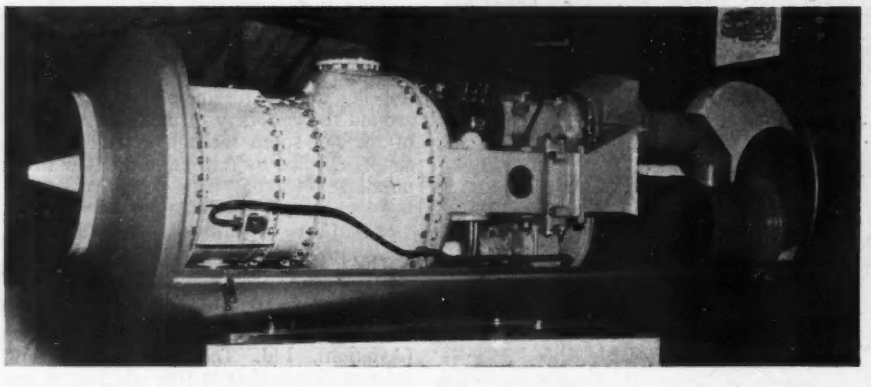
On the far right is shown the centre body of a Napier ram-jet test vehicle: this component divides into two the air entering the pitot intake, and terminates in a set of upstream sprayers. (The complete test vehicle was illustrated on September 30, 1955, page 484.) Within this section are housed the fuel tanks, pumps, control system, and, near the front, instrumentation and equipment for telemetering results to the ground. It is interesting to realise that, when the ram-jet is in action and a steady speed has been reached, zero g will prevail, the vehicle being fully symmetrical, so that the fuel, for instance, will have to be positively displaced from the tanks.



Seen in the centre picture is a Rolls-Royce noise suppressor such as was fitted to the "Avon" R.A. 29 engines of the "Comet" 3. The tailpipe is sharply fluted and provision is made for the airstream to enter the flutes, thus avoiding vortices behind them. The outer periphery of the jet pipe remains circular for structural efficiency and convenience. Near the areas of greatest curvature the flutes are composed of two thicknesses of metal, and the space between is vented to the gas side. It is claimed for this nozzle that it effects a reduction of 5 decibels in the direction of greatest noise emission, and that on a "Conway" by-pass engine the corresponding figure is 12 decibels. The lowest lobe, as can be seen, includes a venturi fitting, which is used to lead dumped fuel away from the aircraft. A fluted tailpipe, also following the principles of F. B. Greatrex, was used on the Bristol "Olympus" engines flown at Farnborough in a "Canberra."

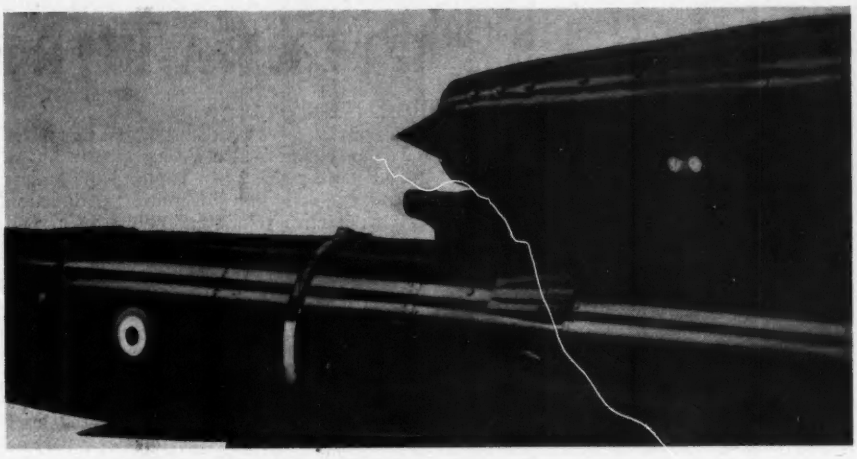


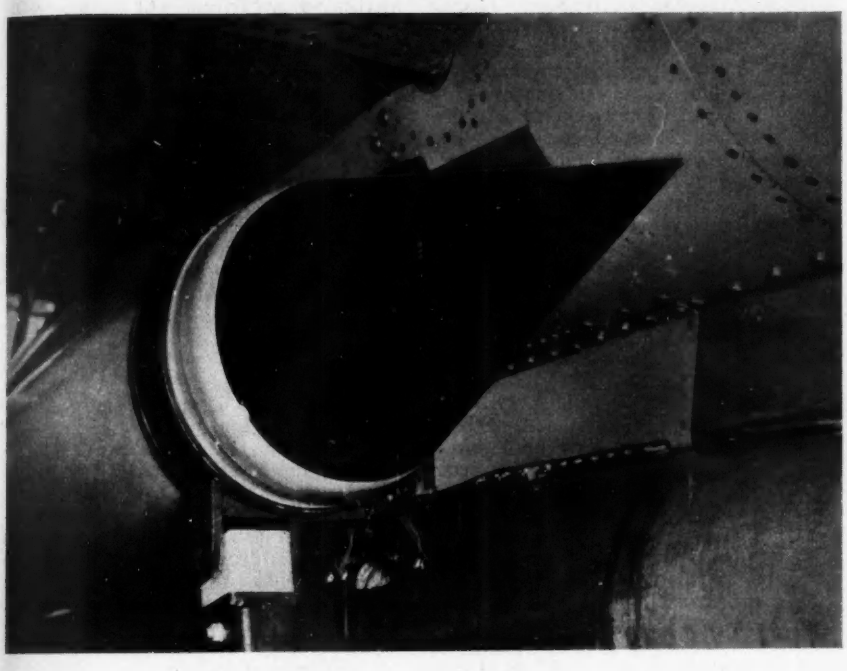
The low specific weight of the gas turbine has caused the auxiliary power plant for aircraft to emerge, after a period of singular unpopularity, as a practical provision for engine starting and other purposes. An additional attraction of the gas turbine is that the relative freedom from servicing allows it to be used as a source of power throughout the flight. The high air consumption of these units often leads to their being installed outside the airframe, and it is for such an application that the airborne auxiliary power plant shown below is intended. At the nearer end of the "pod" can be recognised a Blackburn-Turbomeca centrifugal gas turbine, in this case the "Artouste" fixed shaft power turbine. The engine is direct coupled to an aircooled alternator: with an engine running exclusively for this purpose, no constant speed drive is, of course, involved. Air enters the nacelle at the front, the turbine intakes being one each side of the gearcase. The weight of the engine alone is 278 lb, and a maximum of 475 h.p. is developed with a fuel consumption of 0·99 lb/h.p. hr. Many aircraft gas turbines are started by air turbines, and auxiliary power units may be called upon to supply bleed air to start at least the first engine. For aircraft which are not self-contained in this respect, Blackburn showed also a "Palouste" air compressor, which was fitted inside a streamlined shell, allowing it to be carried as an external store on a military aircraft. This unit has retractable wheels.



Ram-Jet Missile Details

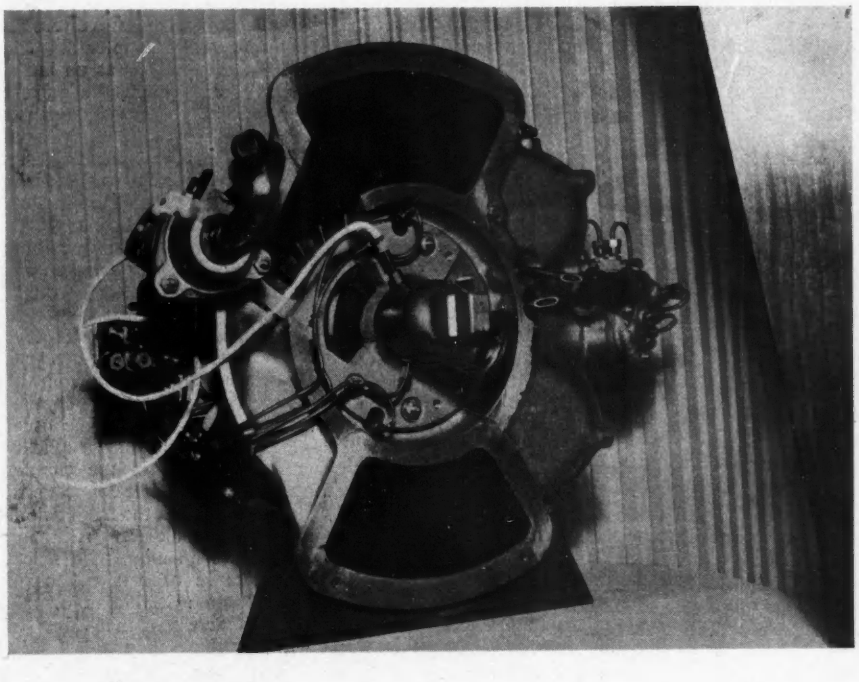
The Bristol "Bloodhound" ground-to-air missile, which was described in an article on page 295 of our issue of August 30 last, is seen in greater detail in these illustrations. The uppermost shows the air intake of one of the Bristol "Thor" engines and, immediately below it, one of the auxiliary intakes which develop pressure to drive the fuel and hydraulic pump turbines. The intakes are covered in this view to conceal the design Mach number, but models have been seen with centre-body conical-shock auxiliary intakes.





The illustration on the left is a close-up of the centre section of the complete vehicle. The boosters have been added—the shoe retaining one of them is visible in the picture above—and in the foreground can be seen the hinged arm of the zero-length launcher. As the missile moves forward the arm swings to follow it, a horizontal pin on the boost attachment lifting out of a groove in the arm as it does so. The cases of the solid-propellant motors are the accepted welded steel cylinders, and they are inclined slightly outwards, implying that the thrust is well balanced between the four boosts. The mounting of the sustainer engine can also be seen, and, behind, a panel of the fairing which occupies the gap between engine and fuselage. The structure of the airframe in this locality, in which most of the loads are concentrated, is evident, screwed fittings being numerous. Also apparent is the slight local thickening of the wing where the pivot shaft runs into it, opposite the point of maximum thickness. Apart from this, the section is the classical Ackeret double wedge; the section on an inclined plane can be seen in the upper view. The wing is fabricated with a number of spars and stabilised by a core, part of which, apparently non-metallic, can be seen.

The missile runs principally on energy derived from the ram air intakes mentioned above. The air is first fed to an impulse turbine driving the fuel pump, and then to a reaction turbine providing pressure for the hydraulic flying controls. The latter motor is seen on the right, with the air inlets facing the camera; out of sight on the right-hand side is a butterfly valve spilling air to limit the delivery pressure. The distinctive feature of this design is that the impeller (which, it can be seen, has but four blades) runs within a shroud which is free to rotate. The idling speed of the shroud is found in practice to be about one-half the impeller speed; assuming that the viscous forces on the faces of the shroud increase faster than linearly with speed, it can be understood that the losses in the pump are reduced by this construction. The rotor speed is 32,500 r.p.m. and the pressure developed 1500 lb per square inch; about 20 h.p. is available from the turbine. The unit is complete with a pressure-sensing hydraulic control system, the plumbing for which can be seen; it includes a non-return valve.



LITERATURE

Kinematics of Machines. By R. T. HINKLE. Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, London, W.1. Price 45s.

THIS book is a very useful one in two ways. Anyone familiar with its contents—and it is, on the whole, an easy book to follow—will acquire confidence to tackle most of the problems likely to arise in machine kinematics ; in a larger sense it will be useful in drawing attention to the fact that machine kinematics is a subject worthy of study in its own right. The preface does not indicate the standard for which it is intended, but since the author is Professor of Mechanical Engineering at Michigan State College, one imagines it to have been written mainly for undergraduate use. In this country it should be particularly useful for the study of machine kinematics in the new courses for the Diploma of Technology. The book contains a very large number of illustrations, mainly line diagrams. This is important, because the author's style is somewhat uneven in quality. At its best it is direct and forceful, in other places the text is not as clear as one would like (transatlantic differences of language usage might account for some of these difficulties). A few references to the work of Leonardo da Vinci in the field of machine design and to advanced treatments of some of the topics treated in the book help the reader to maintain in perspective the development of the subject as a whole. The relation between theory and practice is indicated by photographs and drawings of particular machines and parts. Further help in focusing the reader's ideas is given by introductory paragraphs at the beginning of some of the chapters which explain the purpose of the main topics presented. The numerous diagrams are well-drawn and closely related to the text, but a few could well be larger. The author makes use of worked examples in the text, and further examples are set at the end of each of the main chapters ; no answers for these are given, which is satisfactory for ordinary class-work but is perhaps rather hard on the solitary student.

The first two chapters of the book are introductory in that they are devoted, respectively, to " Terminology and Basic Concepts " and " Equation of Motion, Relative Motion, and Transmission of Motion." A valuable feature here is the presentation of elementary vector notation and methods. That the author has not been afraid to do this shows the extent to which engineers' fear of such formidable mathematical weapons has diminished in recent years. It is, however, a pity that the author has not extended his use of vectors to include the derivation of the expression for the Coriolis acceleration component in a later chapter. The derivation given, although clear and simple, is incomplete (as the author himself recognises) and is therefore not entirely satisfactory. Three methods for the graphical velocity analysis of mechanisms are given, by instantaneous velocity centres and by resolution of linear velocities in Chapter 3, and by relative velocity polygons in the following chapter. Of these, the second is the least important, fortunately, since it is the least well-presented. The rest of Chapter 3 deals with Kennedy's theorem, its use in locating the instantaneous centres in a mechanism, and the subsequent determination of output velocity. The well-known parallel-line construction (an elementary version of Rosenaur's orthogonal velocity vector method) for cases where instantaneous centres are inaccessible is also given.

At the beginning of Chapter 4 the author states the condition governing the direction of the relative velocity of points on a rigid link without justification ; a reference back to the simple explanation, given in Chapter 2.8 would preserve the continuity of the reader's understanding at this point. In the course of this chapter the author shows the advantage to be gained by the use of double points in the analysis of such mechanisms as the oscillating cylinder of Example 4. This is a more important technique than the brief treatment given here suggests, since it may be extended to many other problems and can be used to avoid the cumbersome trial solution shown for Walschaerts valve gear. Despite these criticisms, however, Chapters 3 and 4 present a sound overall picture of the methods available for the graphical velocity analysis of link mechanisms. Acceleration analysis follows in Chapter 5, in which problems involving Coriolis acceleration component and accelerating driving links are included ; also shown is the use of linkage equivalents of mechanisms comprising curved surfaces in sliding or rolling contact (e.g. cam and follower) as an aid to acceleration analysis. The next chapter is entitled " Graphic and Analytical Methods." We would prefer to see a presentation of simple numerical differentiation instead of the direct graphical differentiation shown, of which the practical value is doubtful because of the large errors usually arising from its use. More useful is the selection of graphical methods (e.g. velocity-displacement curves, polar velocity graphs), by which the results of kinematic analysis may be represented. The Ritterhaus construction for both symmetrical and offset cases of the slider-crank mechanism is given, and the chapter concludes with the usual approximate analytical expressions for piston velocity and acceleration. Chapter 7 shows simple constructions for a number of disc cam and follower combinations, together with brief descriptions of more complicated cam types and needs no further discussion here. The frequently neglected topic of pure rolling contact between machine elements is discussed in a short but interesting Chapter 8. The author's intention of using this as an introduction to the following chapter on gearing is a sound one. Naturally, the chief emphasis in Chapter 9 is on the involute tooth form, but the author has also included a brief treatment of cycloidal teeth so that the advantages and properties of the involute form may be more clearly appreciated ; a useful glossary of terms used in describing gear wheels is included in this chapter. A description of methods of producing straight and helical spur gear wheels then leads to a discussion of more elaborate wheel shapes—worm gears and bevel gears of various patterns. The velocity ratios resulting from the combination of gear wheels into ordinary and epicyclic trains are dealt with by the usual methods in Chapter 10. The author quickly dispenses with belt drives in the chapter (No. 11) concerned with flexible connections, thus leaving space to present the main details of several kinds of chain drive. Although this arrangement does no more than reflect the relative importance of belt and chain drives, it is uncommon in books of this standard and so increases the value of this work. The final chapter of the book contains descriptions of a number of ingenious mechanisms (several forms of universal joint, for example) which do not fall readily into any of the previous chapters but which can be expected to whet the appetite of the interested reader.

To sum up, this is a book which contains more useful and interesting material than its number of pages (226) suggests. It will be an asset to any student of the subject who is concerned more with " how " rather than " why," and can follow without trouble the author's abrupt style. Unfortunately, the price is something of a shock even to those accustomed to the cost of books from the U.S.A.

Mechanisms and Dynamics of Machinery. By H. H. MABIE and F. W. OCVIRK. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 68s.

IT is easy to be enthusiastic about this book. Two associate professors of mechanical engineering at a senior American University have given an invigorating new look to a subject which has been almost stagnating for many years. *Theory of Machines* now becomes *Mechanisms and Dynamics of Machinery*, but the change goes much further than the title, as indicated, for example, by the inclusion of chapters on non-standard spur gears ; computing mechanisms; and kinematic synthesis. Although they cover between them merely forty-five pages of the book's total of over four hundred, and are therefore no more than introductory, these chapters show how seriously the authors have tried to keep their course in line with the problems arising in modern engineering practice. For the rest, the book covers the kinematics of link mechanisms, cam-and-follower combinations, and various types of gears, and the dynamics of machines made up of these classes of component. Flexible machine elements are conspicuously absent.

One important feature of the arrangement of the book invites comment ; although various kinds of linkage are described in Chapter 2, velocity and acceleration analysis is left until Chapter 10. The authors' aim has clearly been to use this as an introduction to dynamic machine analysis, but it results in their discussing elementary vectors and relative motion a few pages after the chapter on the kinematic synthesis of linkwork. The underlying reason is presumably that the work is a published version of lecture notes for a two-year undergraduate course, the division occurring between Chapters 9 and 10.

For a two-year course to reach out to the advanced topics previously noticed demands somewhat scanty treatment (the authors call it streamlined) of the elementary aspects of the subject. Students are expected really to know what they should have learnt in previous years. Newton's laws of motion, for example, are not discussed, and little concession is made to the weaker brethren in the way of explanation of systems of units (the authors use pound, slug, foot and second fairly consistently). In their experience, say the authors, students prefer advanced topics and methods to the elementary ones (for example, analytical rather than graphical cam design) and they have shaped their course accordingly. To many this outlook will seem unduly optimistic ; but then it is in the nature of this book to be optimistic.

The text is generally easily followed, the

authors not being afraid to use enough words to explain their meaning adequately. Occasional inept phrases stick out as an obstacle to the reader's train of thought (for example, immediately following the section heading "Angular Motion" is the sentence "Angular motion concerns the angular motion of a straight line"). It would, however, be unfair to concentrate on the faults of a book that contains so much that is right. It is well produced with numerous excellent diagrams, and a generous helping of examples (without answers) appended to each chapter. It demands of the reader only an average undergraduate equipment in pure and applied mathematics, and the ability to be interested in a subject which the authors obviously find interesting themselves. University teachers, and undergraduates with an adult approach to their work will surely welcome this book. It may well be a long time before a better one on this subject appears on the market.

Mechanical Vibrations. By BERNARD MORRILL. The Ronald Press Company, 15, East 26th Street, New York, 10, N.Y. Price 6·50 dollars.

TEXTBOOKS are often either too simple and restricted so that the more intelligent student cannot satisfy his needs or they are more like a treatise suitable for only a handful of experts. This book by Morrill would seem to be a compromise. As a textbook it is suitable for a first degree course and also for use by post-graduates. The basic elementary vibration theory is presented in a manner sufficiently rigorous so that the student will extend himself to master the mathematical techniques which will serve him in his other studies. Some prior knowledge of integral calculus is required, although care has been taken to explain in detail any of the more advanced mathematical operations.

Some elementary considerations of the dynamics of a particle are given as an introduction. This is extremely useful, as it serves amongst other items to define vectors and illustrates their use. Simple harmonic motion is also discussed in this first chapter and treated as the motion experienced by the simplest vibrating system, in the form of a mass controlled by a linear spring, which approach is to be much preferred to that so often encountered of taking it as an acceleration always directed towards the centre, without any further explanation of its physical sense. The usual single and multi-degree of freedom systems are discussed in detail, vector diagrams being relied upon to clarify the physical interpretation of the solutions of the equations of motion obtained by formal mathematics. Both linear and torsional systems are considered, including branched and geared systems. The calculations of critical speeds of shafts are also given. The transverse vibration of beams and the vibrations of continuous systems have been included, but not in a very extensive manner, although an entire chapter has been devoted to a discussion and proof of the Lagrange Equation. A final section gives a useful introduction to electrical analogies for mechanical systems and to the mobility method of solution.

Students will find this a very useful textbook, all the more useful because there are a number of problems with answers at the conclusion of each chapter. Another useful feature is that a short bibliography is given at the end of each chapter. The work as a whole is rather remote from actual engineering practice, nearly all the systems considered are in the "idealised" form, without first having been derived from an actual practical example. Damping is taken as being equivalent to viscous damping without any explanation, and the reader is left with the grave suspicion that this is so because it leads to convenient differential equations for which elegant solutions can be obtained. Coulomb damping is considered, but only briefly. Again, it is not clear why the Lagrange Equation has been dealt with so fully in a book of this scope, as the number of cases to which this equation can be applied in practice is rather limited.

Television Engineering: Principles and Practice. Volume III: Waveform Generation. By S. W. AMOS, B.Sc. (Hons.), A.M.I.E.E., and D. C. BIRKINSHAW, M.B.E., M.A., M.I.E.S. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 30s.

THIS book is one of a series of B.B.C. engineering training manuals. As one would expect from such expert authors, it is a very workmanlike book and covers the subject of voltage waveform generation in a very interesting and thorough manner.

In the opening chapters it is shown that in television engineering, rectangular, sawtooth and parabolic waveforms form the basis of more complicated waveforms and how a sawtooth can be derived by differentiating a parabolic waveform and a rectangular pulse can be derived by further differentiating. Timing of various waveforms is also discussed. A chapter on sine waveforms follows and various circuits are shown. Properties and generation of rectangular waves are then discussed and these chapters cover most common forms of multivibrators and also transitrons. Typical circuits are given and the operating conditions of the valves and waveforms on various electrodes are clearly shown. The chapters on rectangular waveform generation take up more than one-third of the book and are very complete. Chapter 20 starts on the fundamentals of sawtooth waves, the following chapters describing their generation and linearisation. Design methods are given and practical examples are worked out. The book ends with a very short chapter on parabolic wave generation and a brief bibliography.

It is difficult to fault a book of this nature as the subject matter is so carefully selected and described. It is obvious that both authors not only know the subject, but also know how to teach. In addition, the book printing and illustrating is of high standard. The only criticism that we can make is that somewhat surprisingly no mention at all is made of current waveforms. Considering their importance in television this is a strange omission as their generation has peculiar problems of its own. Perhaps this will be covered in one of the other books in the series.

Books Received

Elementary Thermodynamics. Third Edition. By Virgil Moring Faires. The Macmillan Company, 10, South Audley Street, London, W.1. Price 47s.

Engineering Material Machine Tools and Processes. By W. Steeds. Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, London, W.1. Price 35s.

Colliery Year Book and Coal Trades Directory. Thirty-fifth Edition. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 30s.

Geometrical and Mechanical Drawing. By Raymond S. Forbes. B. T. Batsford, Ltd., 4, Fitzhardinge Street, Portman Square, London, W.1. Price 12s. 6d.

British Petroleum Equipment. 1957-58 Edition. The Council of British Manufacturers of Petroleum Equipment, 2, Princes Row, Buckingham Palace Road, London, S.W.1. Price 50s.

Aerodynamic Components of Aircraft at High Speeds. Volume VII: High Speed Aerodynamics and Jet Propulsion. By A. F. Donovan and H. R. Lawrence. Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 120s.

Technical Reports

Scientific and Technical Translating and other aspects of the language problem, U.N.E.S.C.O. The United Nations Educational Scientific and Cultural Organisation, 19, Avenue Kléber, Paris (16e). Obtainable in the United Kingdom from H.M. Stationery Office, York House, Kingsway, London, W.C.2. Price 20s.—At least 50 per cent of the scientific literature published globally cannot be read by half the scientists in the world because of language difficulties. Nearly two-thirds of all engineering technical literature published appears in English, but more than two-thirds of the world's professional engineers cannot read English; a still larger proportion of English-reading engineers cannot read scientific literature in other languages.

Problems suggested by these and other facts, are examined in the latest U.N.E.S.C.O. publication, "Scientific and Technical Translating," the fourth volume in the organisation's series on documentation and terminology in science, and the result of collaboration between more than 200 experts representative of twenty-one countries. The report compares systems and methods in use all over the world. Among specific suggestions offered to help surmount the language obstacle is a proposal for the formation in other countries of registers of specialist translators similar to the ASLIB register in Britain, and the linking of them internationally.

Special sections discuss problems peculiar to the translation of Russian, Chinese and Japanese, and examine speculative ideas on the concentration or adaptation of existing languages for universal use, or the use of "constructed" ones such as Esperanto and Interlingua. Another chapter, on language-learning for scientists, refers to the importance of tackling the matter early. The possibilities of machine translating are examined. A machine can be "taught" to recognise a whole unit phrase in one language and to type out a corresponding phrase in another. It can be so constructed that when, say, a long German word is fed into it which it does not immediately recognise, the machine will cut off the terminal letters and syllables one by one until what remains is something previously stored in its "memory" whose equivalent in the other language it is, in fact, able to recall.

It is considered that mechanical translating may make a valuable contribution though economically it may be worth while only in certain circumstances. An extensive bibliography is given in an apprendix.

Metallurgical Investigations of Sodium Heat Transfer Rig. By A. G. Ward and J. W. Taylor. Atomic Energy Research Establishment, Metallurgy Division paper A.E.R.E. M/M 148.—Sodium attack on stainless steel and nickel has been studied, both when free of and when contaminated with oxygen. Static and dynamic tests have been carried out at temperatures in the range 300 deg. to 600 deg. Cent. Miscellaneous investigations have also been carried out on components from a double-annulus heat exchange rig of stainless steel and nickel. Under test conditions, 18/8 stainless steel containing free carbide is heavily attacked in all cases. The evidence suggests an intergranular decarburising action modifying spheroidal carbide by diffusion of the latter phase into the matrix. Under similar conditions nickel suffers no detectable corrosion. It is recommended that, before use in systems containing sodium at temperatures above 300 deg. Cent., stainless steel should be inspected to verify that: (*a*) the specification has been met; and (*b*) there is no free carbide.

Recherches sur le Mécanisme d'Oxydation de Cristaux Uniques de fer A Haute Température et sous Basse Pression d'Oxygène. By J. Bardolle. Publications Scientifiques et Techniques du Ministère de l'Air, No. 327. Service de Documentation et d'Information Technique de l'Aéronautique, Magasin C.T.O., 2, Avenue de la Porte-d'Issy, Paris (15e). Price F.fr.1000.—By means of microscopic X-ray and electron diffraction techniques, the author studies the oxydation of iron as a function of pressure, temperature and crystalline orientation of the metal. The method of preparing the specimens is described, together with that of obtaining a check of surface quality by means of interference colour in the oxide layer. In tests at elevated temperatures, but at a reduced oxygen pressure, the information was observed of "seed" crystals of oxide, and at higher pressures of oriented layers of oxide. The study reveals certain parallels between the structure of the metal and that of the oxide film.

Purification of Graphite. By P. M. Harris. Atomic Energy Research Establishment, Information Office paper A.E.R.E. Inf./Bib.109. H.M. Stationery Office. Price 1s. 6d.—Forty-two open literature references and ten unclassified American report references are given for the period 1926–1955.

Engineering and Marine Exhibition

No. III—(*Continued from page* 342, *September* 6)

The Engineering, Marine, Welding and Nuclear Energy Exhibition at Olympia, to give it its full title, ended yesterday. It was the twenty-first of the series and it is just fifty years since the first was held. The interest the exhibition aroused around the world was indicated by the fact that no less than fourteen ambassadors attended the inaugural luncheon and that there were guests from almost every part of the world. In a speech he made at the luncheon held at Olympia on the opening day, Sir Christopher Hinton referred to the Exhibition as a "practical university of the engineering art." The organisers can well claim it to be an apt description. For the Engineering and Marine Exhibition has become nearly unique in this country, as our accounts of the exhibits demonstrate, in being not a specialised trade show but a general engineering exhibition.

Babcock and Wilcox, Ltd.

THE nuclear power side of the activities of Babcock and Wilcox, Ltd., was given particular prominence upon its stand this year at Olympia. The stand was dominated at one end by a painting representing a modern 500MW nuclear power station of the gas-cooled, graphite-moderated design. Sectioned models were used to show the construction of a typical steam raising unit or heat exchanger such as the firm installed at Calder Hall, and a reactor pressure vessel for a pressurised water reactor to operate at 1200 lb per square inch. A display was arranged to show how the designed output and efficiency of a nuclear power station depended directly upon effective welding techniques for heavy mild steel and alloy plates, and examples of this work were shown by means of photographs. The work of the company's research department in the nuclear field was represented by a constructional model which was made to assist in building, for the Atomic Energy Authority, a complex equipment known as the "Dido Loop," the purpose of which is to investigate the effect of "in-pile" radiation on the aqueous corrosion of water-cooled fuel elements.

This company has for some years been co-operating with the Atomic Energy Research Establishment on a design study of reactors and steam-raising plant for marine application. It has also, as recently announced, been collaborating with Cammell Laird and Co. (Shipbuilders and Engineers), Ltd., in studies relating to the development of an economic nuclear propulsion unit. In this direction a model of interest was a hull section of a large tanker with a possible arrangement of a nuclear propulsion plant based upon a gas-cooled, graphite-moderated reactor. At present work is being concentrated on the application of such a plant to a tanker of about 65,000 tons deadweight capacity.

Amongst the exhibits concerned with the conventional land and marine steam-raising plant made by the firm was the model illustrated in Fig. 68. This model shows the arrangement of a large "Radiant" boiler, which is now under construction for supplying steam to a 200MW turbine. This boiler will have a maximum continuous rating of 1,350,000 lb per hour, a superheater outlet pressure of 2450 lb per square inch, and a superheater outlet temperature of 1055 deg. Fah. It is equipped with a reheater and multi-looped economiser arranged in the steam-cooled tube enclosure at the rear. The furnace is designed for oil-firing and the front wall is fitted with twenty-four Babcock oil-burners.

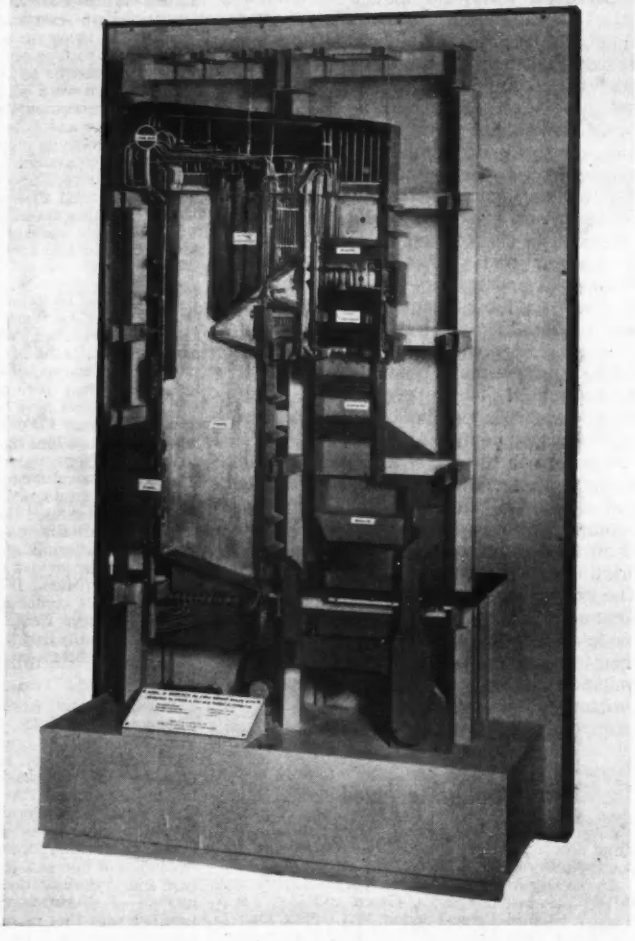


Fig. 62—Model of an oil-fired "Radiant" boiler equipped with a reheater, and built to steam a 200MW turbo-alternator—Babcock

A 24½in land-type register was exhibited, complete with a "Y-jet" atomiser and equipped with a "Fireye" flame-monitoring device; and other types of atomisers shown included the high-pressure return-flow design recently introduced by the firm.

Modern Babcock practice in boiler casing was demonstrated by a sectional model of a tangent-tube boiler wall showing the skin-casing construction. A display showing the economic advantages of a well-designed soot-blowing system included two new developments in the firm's shielded soot-blower nozzles and a system of electrical sequence control. This system was demonstrated on an actual soot-blower control cubicle operating an animated diagram, to show the automatic control of blowing sequence in a typical boiler.

Marconi International Marine Communication Company, Ltd.

A new version of the "Martinet" automatic helmsman was shown by the Marconi International Marine Communication Company, Ltd., Chelmsford, Essex. This equipment is known as the "Martinet II" and it is produced jointly by the exhibitor and by Hartley Electromotives, Ltd. It is intended for small ocean-going ships and for coasting or fishing craft of steel or wooden construction. The "Martinet II" is a non-gyroscopic equipment in which a magnetic-north-seeking device is used to detect any deviation from a set course; information from this reference system is fed to a relay unit which controls a reversible motor, and the correct amount of counter helm is automatically applied through a chain coupling between the motor and the steering mechanism. This means of holding course automatically, or of manœuvring with the steering gear under power control, relieves the helmsman of the duty of steering.

With the help of a remote control unit which can be held in the hand, the ship can be steered from the wing of the bridge or any other vantage point. The unit has a "follow-up" mechanism, so that after the vessel has steadied on her new course the automatic pilot can be brought in from the remote position without returning to the wheelhouse. When weather conditions or trawling operations cause the vessel to carry some permanent helm, a special weather helm device ensures that the necessary amount of helm is automatically and continuously applied. Adjustment can also be made for "tight" or "loose" steering, so that the amount of correcting rudder movement for a given deviation from course can be varied to suit the prevailing conditions. All the controls for the operation of the "Martinet II" are grouped in a unit which can be mounted on the bulkhead close to the steering position. A four-position "function switch" enables the helmsman to select remote or automatic power control or hand steering.

An alarm signal is included to give warning of any failure of the automatic system, and an electromagnetic clutch on the motor unit ensures that manual steering is instantly available on turning the function switch to "hand." There is also a special "course trim" switch on the control unit, to enable the navigator to alter course step by step in 1 deg. movements. Each time the trim switch is pressed a 1 deg. alteration is made to port or starboard as required. Ships fitted with hydraulic or "Telemotor" steering

are supplied with a rudder feedback unit which is coupled to the rudder post by means of adjustable linkage rods, and connected to the control unit in the wheelhouse by cable.

Another exhibit seen on this stand was the "Protector," an equipment based on the Marconi-Postans ultrasonic system for preventing fouling on ocean-going ships. The "Protector" is designed to inhibit the accumulation of barnacles and other marine growths and it operates by applying ultrasonic vibration to the shell plating through transducers fixed inside the hull. Ultrasonic pulses are generated by a transmitter unit installed in the engine-room; this unit is designed for service in locations where the usual care of radio equipment is not afforded. Two motor alternators with control and change-over equipment provide alternative sources of power and enable the transmitter to operate continuously. The output from the transmitter is fed to one or more transducers coupled to the ship's hull in selected positions, so that the whole shell of the ship is maintained in continuous ultrasonic vibration. The system will not detach existing growths and the equipment must, therefore, be kept operating continuously. Automatic alarm devices in the engine-room and on the bridge give warning of failure either of the mains supply or of any part of the installation.

W. H. Dorman and Co., Ltd.

A complete range of the "L" series of diesel engines made by W. H. Dorman and Co., Ltd., Stafford was exhibited. It included examples of the two, three, four, five, six and eight-cylinder engines having an overall power output from 20 h.p. to 160 h.p. when naturally aspirated, or 200 h.p. when pressure charged, at running speeds from 1000 to 1800 r.p.m. The new "Q" range of engines introduced by the firm was represented by a "6 QA" six-cylinder naturally aspirated engine (Fig. 63). This design of engine has an approximate power range from 100 b.h.p. at 800 r.p.m. to 262·5 b.h.p. at 1800 r.p.m., with an envisaged extension of the maximum speed to 2000 r.p.m., when the power output would be 287·5 h.p. When the engine is pressure charged the approximate outputs become 130 h.p. at 800 r.p.m., 340 h.p. at 1800 r.p.m., and approximately 390 h.p. at 2000 r.p.m. This new range will ultimately comprise five, six, eight and twelve-cylinder engines, with an overall power range from 85 h.p. at 800 r.p.m. to nearly 800 h.p. at 2000 r.p.m.

The engines are to be manufactured in both in-line and vee form, having been designed to suit the widely varying needs of industrial, automotive, rail traction, and marine applications. Their screwed parts will have unified screw threads and throughout the series standardisation of components will be introduced to the maximum permissible extent. The five and six-sylinder engines will be available with vertical in-line cylinders, or alternatively with horizontal cylinders, whilst the eight and twelve-cylinder engines will have the cylinders in vee form. All models will be available in naturally aspirated, mechanically supercharged and turbo-charged form, and it is intended to produce engines for operation on natural gas as well as diesel fuel.

With a bore of 6·25in and a stroke of 6·5in this engine has a total swept volume of 1196 cubic inches or 19·6 litres. The rigid cast iron crankcase and cylinder unit extends below the crankshaft centre line and is fitted with "chrome-hardened" wet liners, the bearing caps being underslung. Each of the two cylinder heads covers three cylinders and is fitted with aluminium rocker boxes with integral rocker brackets. The renewable valve caps and seats are stellite faced, and one inlet and one exhaust valve is fitted to each cylinder. Helical gears at the rear drive the camshaft, fuel injection pump and oil pump, and standard flywheels are available to suit over-centre industrial or automotive clutches.

The C.A.V. fuel pump is driven through a short cardan shaft, and a diaphragm fuel lift pump is fitted to the fuel pump body as well as an excess fuel device for cold starting. Four alternative types of governors are available for the engine. Pressure-charged engines are fitted with a Godfrey Roots supercharger, which is mounted on the offside of the engine and driven off the rear.

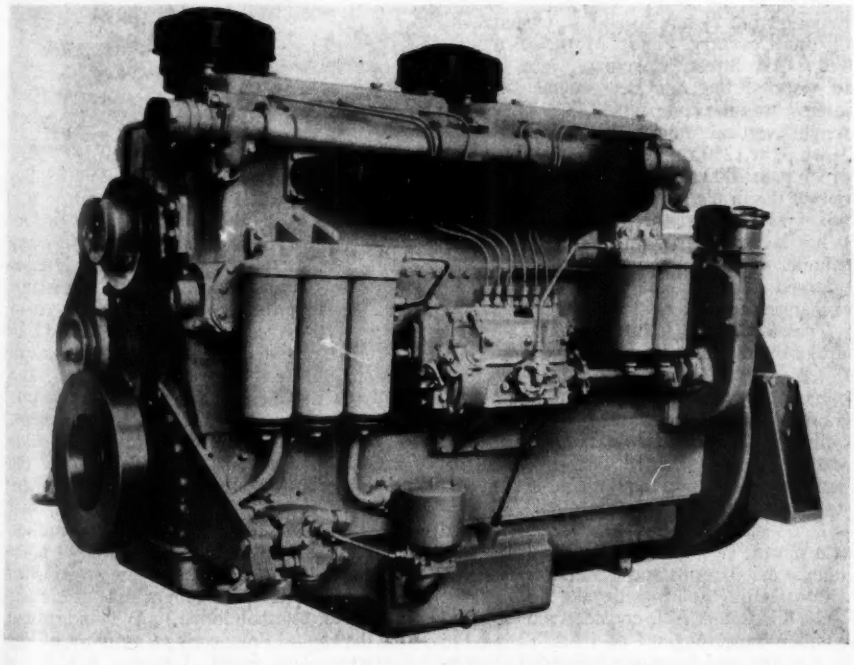


Fig. 63—Six-cylinder industrial diesel engine with power range from 100 b.h.p. at 800 r.p.m. to 262·5 b.h.p. at 1800 r.p.m. When pressure charged the output is 130 b.h.p. at 800 r.p.m. and 350 b.h.p. at 1800 r.p.m. on the 24 hour rating—Dorman

Saunders Valve Company, Ltd.

Diaphragm valves of various kinds and sizes were demonstrated by the Saunders Valve Company, Ltd., Cwmbran, Mon, together with a "Safran" pump arranged with automatic float control and as self-contained electric units. We illustrate in Fig. 64 one of the firm's type "A" 3in

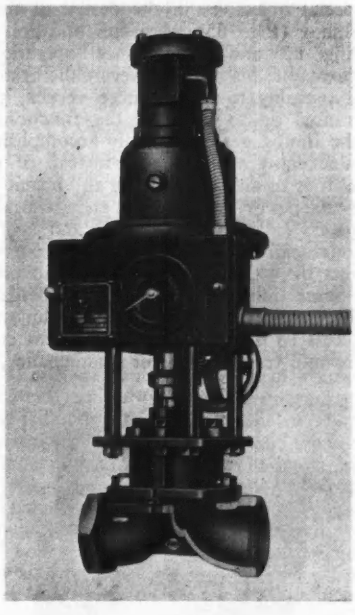


Fig. 64—Diaphragm valve with electric actuator driven by a ⅛ h.p. motor—Saunders

valves fitted with a "Rotork" actuator. This actuator is driven by a ⅛ h.p. electric motor with micro-switch control, which comes into effect in the event of an obstruction preventing the valve being fully closed. An indicator shows the valve setting and a handwheel connected through bevel gearing to the valve spindle can be used in emergency.

Pressure closing and pressure opening valves with alternative forms of positioning apparatus were used to show automatic control for fluid systems. For working in acid-laden atmospheres the firm makes a range of plastics valves, and a recent production is a valve with a stop which prevents over-closure and serves to give visual indication of the valve setting.

The pump exhibits included a portable engine-driven automatic self-priming set for handling dirty water in which small solids are suspended. The "Safran" hot water circulator, for installing directly in pipelines, is designed to permit gravity circulation when required.

Sigmund Pumps, Ltd.

The industrial self-priming pumps shown by Sigmund Pumps, Ltd., Team Valley, Gateshead, 11, were described in our issue of February 24, 1956, and there was also exhibited on this firm's stand a recently introduced marine pump which incorporates the self-priming feature. These "Sigmarina" pumps, as they are known, are made in a range covering 2in to 10in branches, and outputs of up to 700 tons an hour against heads of up to 110ft. Their design is such that both air and water can be handled and even when operating on an empty suction line the water recirculating in a pump casing prevents damage for long periods.

Representative examples of other pumping equipment made by the firm included chemical, oil refinery and other industrial pumps, unchokeable pumps, hot water circulators and general service pumps.

Sciaky Electric Welding Machines, Ltd.

A new series of high-speed, air-operated, spot welding machines, which are designed to reduce to a minimum non-operational times, was shown by Sciaky Electric Welding Machines, Ltd., Slough, Bucks. Three main sizes, 15kVA, 25kVA and 50kVA nominal (each with throat dimensions up to 36in diameter) are available.

Special objectives in the design of these machines (Fig. 65) were simplification of tooling up and maintenance operations. For example, the job of lowering the bottom arm assembly to obtain more vertical gap clearance, or to examine the functioning of the timing gear, is rapidly accomplished by slackening a single bolt, instead of the usual four or six. The timing equipment—a four-channel thyratron circuit giving variable "squeeze" "weld," "dwell" and "off" periods—can be quickly extracted from the cabinet by withdrawing a chassis and plug. The same timer is interchangeable between the different sizes in the range of machines.

Access to the main primary current contactor and transformer, for maintenance, is

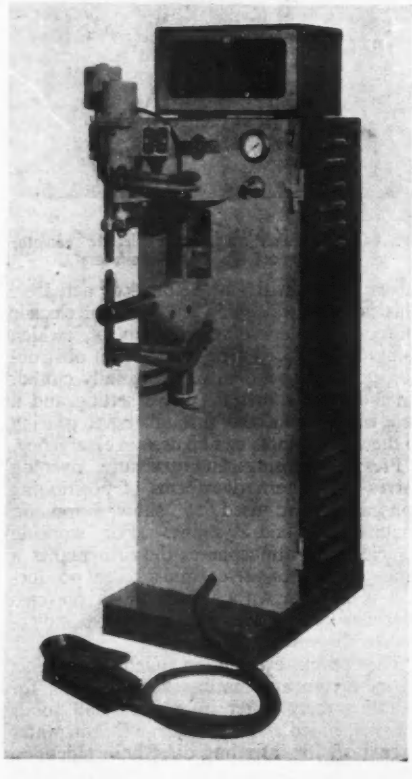


Fig. 65—"Rapid" spot welder designed for production welding with minimum non-operational times—Sciaky

given by wing type doors. The electronic and pneumatic controls are visible from the work station so that the operator can observe the weld setting results and make adjustments without moving from the working position. The pneumatic system is designed for high welding speeds and the 15kVA model, for instance, will weld at up to 250 spots per minute. The cylinder seals are moisture resistant and shrink proof.

On the same stand there was a new foot-operated, general-purpose, spot welding machine, "SF15" (Fig. 66), having an electrical rating of 15kVA. The top and bottom arms have a limited amount of extension and retraction, and they are machined at both ends for vertical and angular electrode shanks to give maximum work clearances. The welding capacity is stated to be 14+14

Fig. 66—Foot-operated general purpose spot welder —Sciaky

s.w.g. in mild steel sheet. Both electrodes are water cooled and are machined with a $\frac{1}{8}$in taper to B.S. 807. A smoothly adjustable electrode stroke can be obtained up to a maximum gap of $2\frac{3}{4}$in. The adjustment is made, without having to open covers, through a stop screw on the pedal bracket. Electrode pressure is provided by an adjustable spring. The pedal length is adjustable and the normal height above floor level is less than 9in. The main frame is built of fabricated steel and hinged clamshell rear covers give access to all internally mounted controls.

The welding transformer is air cooled; heat tappings are provided and the door covering the link switch is secured by a Yale lock. Primary current control is effected by a heavy-duty electromagnetic contactor mounted as a unit with the welding transformer. The welding circuit is controlled by a Sciaky thyratron timer giving a range of weld times from 2 to 150 cycles. The setting dials are visible and adjustable from the work station.

Coventry Victor Motor Company, Ltd.

Most of the diesel and petrol engines ranging from $2\frac{1}{2}$ h.p. to 30 h.p. on the stand of the Coventry Victor Motor Company, Ltd., Cox Street, Coventry, were familiar to visitors, but one new engine of some interest was the compact AD.3. This lightweight vertical air-cooled engine develops 5·4 h.p. at 1250 r.p.m., 7 h.p. at 1500 r.p.m. or 9 h.p. at 2000 r.p.m., and it was shown with one of the firm's reduction and reverse gearboxes as supplied for lifeboat installations. It has been primarily introduced as a single-cylinder version of the "Vixen" 14/22 h.p. opposed piston engine and many parts are exchangeable between these two engines.

The AD.3. has a bore of 90mm and a stroke of 100mm and its fuel consumption is stated to be 0·47 pint per b.h.p. per hour. It has a non-corrosive cast-aluminium-alloy crankcase with a renewable liner fitted to the cylinder. Pressure lubrication is provided and each engine is fitted with a C.A.V. fuel pump and injection equipment and a cold starting injector.

The Victor "Vixen" has been developed as a marine propulsion unit for Class "A" lifeboat installations and a model was shown, with cast alloy housings to take the gearbox. These lightweight, air-cooled, twin opposed cylinder diesel engines of from 12 h.p. to 20 h.p. are used for many industrial applications and one was directly coupled to a 9kW generator on the firm's stand at Olympia.

Department of Scientific and Industrial Research

The British Iron and Steel Research Association was responsible for two of the exhibits on the D.S.I.R. stand. One was a machine-performance recorder (Fig. 67) making use of perforated tape, and the other a "packaged" device known as a "translator." The translator is said to be a refinement of a conventional relay gear—it takes the low-power electrical signals sent by the operator of, say, a steel rolling mill, and "translates" them into control signals at the required power level. The equipment is constructed from motor uniselectors and relays of the sort used in telephone exchanges. To demonstrate the application of the equipment, the exhibit included a large photograph of a blooming mill on the side of the stand. The photograph had on it a calibrated screw-down dial about 2ft in diameter, and moving pointers that indicated screw-down setting as in a mill. There were four switches on which settings could be made to represent the required number of rolling passes, and the cross-sectional dimensions and weight of the ingot to be rolled. There were also three push-buttons labelled "insert data," "next pass" and "reset."

In an actual mill the operator checks

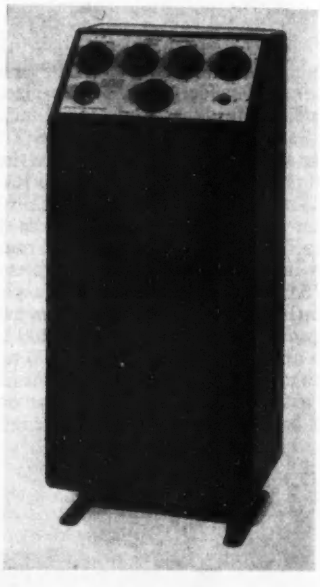


Fig. 67—The B.I.S.R.A. performance recorder —D.S.I.R.

the settings of the four switches on receiving each ingot. After making any changes that might be desired, he presses the insert data button. The translator then relates the received information to one of the rolling schedules stored in what is called its "dictionary" (which can contain up to 150 different examples), and sends appropriate electrical signals to operate the screws, manipulators and tilting fingers. In this way the mill is automatically made ready for the next pass. Depression of the next pass button after each pass causes the appropriate further instructions to be sent to the mill. After the last pass, restoration of the setting for the first pass follows automatically. (The reset button is only used when work on a particular ingot has for some reason to be abandoned.) We understand that the Digital Engineering Company, of 136, Battersea Park Road, London, S.W.11, is at present making an advanced form of translator to control operation of the 48in

blooming mill now being installed at Stewarts and Lloyds, Ltd., Corby.

The Digital Engineering Company also produces the B.I.S.R.A. performance recorder. The exhibit used to demonstrate this was in sections representing respectively a machine shop and an accountant's office. Next to a photograph of a machine appeared the recorder itself. It is described as "a new link between shop and office, bridging the gap between production and accounting." Machine time spent running, idling, or stopped is recorded on punched tape, and the information made available in this way facilitates the allocation of costs and the planning of production programmes. It is reported that recording equipment of this kind was satisfactorily installed this year at the Cardiff works of Guest, Keen and Nettlefolds.

Also represented on the D.S.I.R. stand was the British Non-Ferrous Metals Research Association. Specimens that had been chromium-plated respectively by existing methods and by a new process, and subsequently exposed to the same industrial atmosphere, were displayed for comparison. The additional protection afforded by the new process was apparent from inspection of the specimens. The benefit is said to result from the greater thickness of chromium that can be deposited satisfactorily when a plating solution developed by the Association is used. It is explained that existing methods of plating result in crazing when the thickness of the layer exceeds about 25 millionths of an inch. The cause of this is seen in the concentration of stress at oxide inclusions. Measurements of strain carried out by the Association in the course of plating are reported to have shown that, while most catalysts give rise to tensile stresses, the use of some leads to compressive stresses. It is claimed that a certain combination of catalysts has been found to give zero resultant stress. The disadvantage of the new solution, the originators point out, is that the coating produced is dark, and, where a bright finish is desired, mechanical polishing is necessary. It is emphasised that the process is not thought to be completely fit for commercial exploitation yet, and development is still under way.

Work at the Mechanical Engineering Research Laboratory and the National Physical Laboratory was represented by exhibits dealing with the behaviour of materials, hydraulic machinery, lubrication, calibration of instruments, and so on.

Henry Pels and Co., Ltd.

The plate fabrication plant displayed by Henry Pels and Co., Ltd., 32-38, Osnaburgh Street, London, N.W.1, included a new combined high-speed shear and nibbling machine designed to shear plates up to $\frac{1}{16}$in thick and nibble plates up to $\frac{1}{4}$in thick from the edge or the inside. This machine (Fig. 68) is driven by a 3 h.p. motor through a variable speed gear giving a stepless range of cutting strokes from 650 to 1600 per minute. Fifteen stroke length settings up to $\frac{3}{8}$in are available, and the machine can be supplied with a throat depth of 42in or 50in.

The top tool can be raised or lowered by a handwheel for height adjustment with the machine running and to enable cuts to be started inside a plate. The top tool can also be rotated whilst the machine is running so that cuts can be made in any direction. The equipment on the machine includes a circle-cutting attachment, a straight edge guide, a flanging attachment and special tools for beading, joggling, louvring and dishing.

An 80-ton press brake shown on the stand had a welded plate frame with its standards connected by tubes and the table suspended between them on the cardan principle to ensure an equal distribution of the load. It is fitted with pneumatically operated and electro-magnetically controlled single disc friction clutch and brake. It can operate at seven or thirty strokes a minute. The maximum rated pressure of the machine is exerted with the eccentrics at 90 deg. above bottom stroke, and it will bend sheets up to 8ft by $\frac{5}{16}$in with a minimum size of flange of $2\frac{3}{4}$in.

In addition to three sizes of combined punching, shearing, cropping and notching machines, the firm also showed a single ended punching machine of $1\frac{1}{16}$in diameter through $\frac{5}{8}$in plate capacity, with a 32in throat. On this machine the punch can be lowered down on to the work by a hand lever whilst the machine is running, and it remains on the centre mark until the hole is punched, when it returns to its upper position. The slide can also be set to "float" so that the punch lightly taps the work on each idle stroke whilst the operator uses both hands to position the plate.

Broom and Wade, Ltd.

The well-known range of air compressors and pneumatic tools made by Broom and Wade, Ltd., of High Wycombe, Bucks, now includes a compressor specially designed to supply oil-free air for chemical, food processing and other plants. This dry cylinder, carbon ring, single-stage machine has an output of 100 cubic feet of free air per minute at 100 lb per square inch pressure. Cast iron pistons are fitted with high-quality carbon, solid and segmented piston rings which are inherently self-lubricating. An internal spring ring is fitted to the pistons, which are carried on non-corrosive piston-rods, and the carbon rings are chemically inert to most acids, alkalis and corrosive salts. A scraper fitted on a diaphragm in the cylinder base prevents oil entering the cylinders.

The firm's new "MV60" pneumatic drilling and reaming machine for holes up to $1\frac{1}{4}$in diameter is fitted with a multi-vane motor and is stated to develop nearly three times the torque of the firm's normal drills. It weighs some 24 lb and is available with either a grip handle or a feed screw. The twist grip throttle gives full speed control and a safety locking device ensures that it does not come into operation until in position.

Air Control Installations, Ltd.

The air cleaning plant displayed by Air Control Installations, Ltd., Ruislip, Middlesex, included a new large capacity equipment for industrial and commercial establishments which is designed to reduce scheduled filter maintenance to a minimum. This equipment is known as the "Rollotron" and a typical installation is shown in the sectional photograph reproduced in Fig. 69.

Each installation consists of one of the firm's "Calmet" electrostatic precipitation units, through which the air is first drawn and the

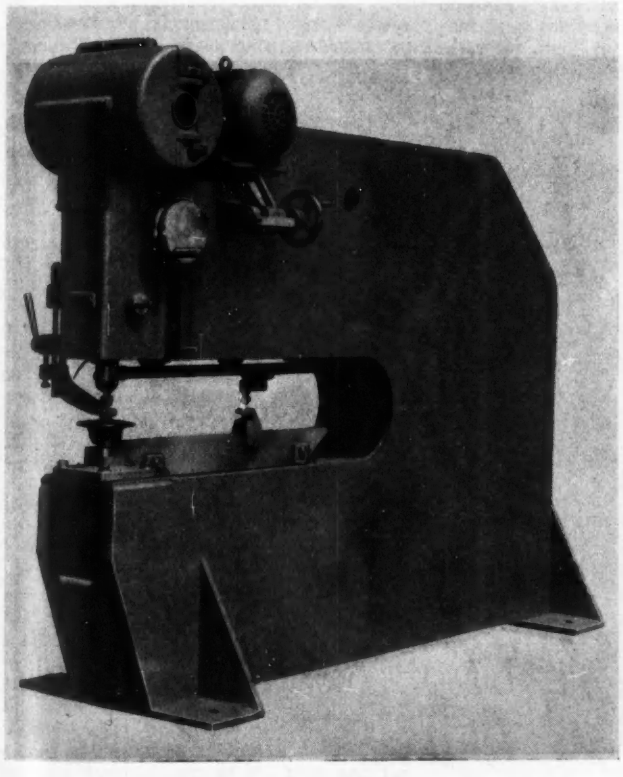


Fig. 68—Combined high-speed shears and nibbler for plates up to $\frac{1}{4}$in thick—Pels

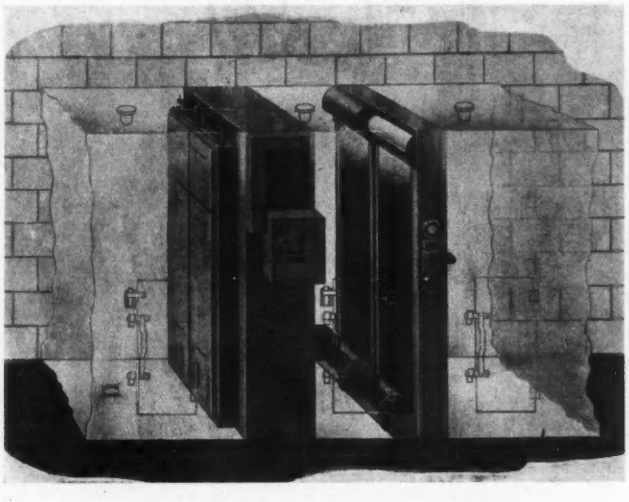


Fig. 69—Electrostatic air cleaning installation with a filter curtain for continuously removing dust—Air Control Installations

dust particles in suspension deposited on the metal plates of the collector element. When the dust particles have built up sufficiently the accumulations are drawn off the plates by the air stream and carried on to what is termed a " storage " unit a short distance downstream of the system (on the right in the illustration). This storage unit consists of a fabricated metal frame on which there is suspended a filtering curtain of bonded glass fibres. This curtain effectively retains the dust particles whilst offering a minimum resistance to the flow of air.

The filtering medium is carried between two sets of rolls, one at the top and the other at the bottom of the frame. The upper, or feed, roll is of sufficient size to carry some 65ft of the medium, and the lower roll is driven intermediately at predetermined intervals by an electric motor through reduction gearing to draw a clean section of the curtain into the air stream. A slight frictional braking effect is imposed on the upper roll to maintain tension in the curtain against the pressure of the air flow. When the length of curtain stored on the upper roll has been extracted a visual or audible alarm comes into effect to indicate the need for replacement.

These units are made in a number of sizes for air flows ranging from 4550 to 94,000 cubic feet per minute, and they can readily be arranged in parallel to suit the form and required capacity of an installation.

Another recent introduction by this firm is a small, self-contained precipitator for removing oil mist and fumes from the vicinity of machines, oil quench tanks, &c. The mist or fume laden air is drawn into the lower part of the cabinet of this equipment and up through an electrostatic precipitator unit, where oil content is deposited on the plates until it forms droplets which fall down into a recovery tank in the base.

Worthington-Simpson, Ltd.

Two models of a new range of two-stage, oil-cooled rotary air compressors introduced by Worthington-Simpson, Ltd., Newark, were shown for the first time at Olympia. These machines, for industrial use, are made in a number of sizes covering capacities from 200 to 1200 cubic feet per minute at pressures up to 120 lb per square inch. In these sliding vane compressors a large quantity of oil is injected whilst they are running. This oil, in addition to lubricating all the moving parts, serves to provide an effective seal to prevent air leakage between the sliding vanes, and it acts as an internal cooling agent. The effectiveness of this cooling is stated to be such that the final air temperature is below 200 deg. Fah., or some 100 deg. Fah. cooler than the air delivered by a conventional reciprocating compressor of similar capacity.

A typical two-stage compressor of the design is illustrated in Fig. 70. The two compressor cylinders of close-grained cast iron are arranged in line in a fabricated steel cylinder which incorporates the oil reservoir. The first-stage rotor is forged integrally on the mild steel shaft and, at the opposite end to the driving coupling, is extended to carry the second-stage rotor. This rotor shaft assembly is carried on three sets of ball and roller bearings, and the second-stage rotor is designed to float, self-positioning, on the main shaft. The rotors are slotted to precision limits and a blade of plastic material slides freely in each slot.

Air is delivered from the main casing into an oil separator above. From this separator the oil is returned to the casing sump via a tubular water-cooled heat exchanger at the side of the machine. The oil-free air is delivered through a non-return valve at the top of the oil separator. An oil-bath suction filter and silencer ensures cleanliness of the intake air and reduces compression noise. A hand unloading gear is fitted for use when starting the machine.

Thos. Firth and John Brown, Ltd.

Some particularly fine examples of heavy forgings produced in the firm's works, which were displayed by Thos. Firth and John Brown, Ltd., Atlas Works, Sheffield, had a total weight of some 120 tons. A forged shaft for a 120MW steam turbine rotor, which was shown in the rough machined, smooth bored condition, weighs about 31½ tons. This shaft, in 3 per cent chrome molybdenum steel, has an overall length of 18ft 8in and a main diameter of 4ft 6in. When finished machined by the Metropolitan-Vickers Electrical Company, Ltd., to which it is being supplied, the shaft will weigh 23·2 tons complete with stainless steel runner blading.

A hollow forged steam drum weighing 50 tons, made for Mitchell Engineering, Ltd., has a length of 33ft and an outside diameter of 6ft 2in. It is made from carbon steel of 32/36 tons ultimate tensile strength and is designed for a 1550 lb per square inch internal pressure. A die block made for High Duty Alloys, Ltd., by the firm is used in the production of oleo-head forgings which weigh 175 lb each and are made in a 12,000-ton hydraulic forging press.

Richard Klinger, Ltd.

In addition to a comprehensive selection of the packings, jointings, gauges and valves made by Richard Klinger, Ltd., Sidcup, Kent, this firm arranged a working rig to show the operation of a " Klingermatic " automatic valve control system. This exhibit (Fig. 71) incorporated four different sizes of " Klingerflow " valves, with a hydraulic operating pump, a panel and indicator system.

In the demonstration equipment fluid from a 1-gallon tank at the top of the cabinet passes though a needle valve to the pumps. There is a small electric pump and an alternative four-cylinder transmitter, or two-directional pump operated by a large handwheel for manual control. The motor-driven pump passes the hydraulic fluid to a blow-off valve, which, if the cylinders are not being operated, returns the hydraulic fluid to the supply tank. When operating the hydraulic cylinders, the fluid flows from the transmitter or the electric pump via an automatic change-over valve to a metering and reversing valve, which is also used as a switch for the pump. The metering and reversing unit then passes the fluid to the selector valves.

On the rig a 1in and a 3in " Klingermatic " valve are controlled by electrically operated selector valves, which, in turn, are push-button operated. These " Klingermatic " valves can only be fully open or fully closed. A 2in and a 6in " Klingermatic " valve on

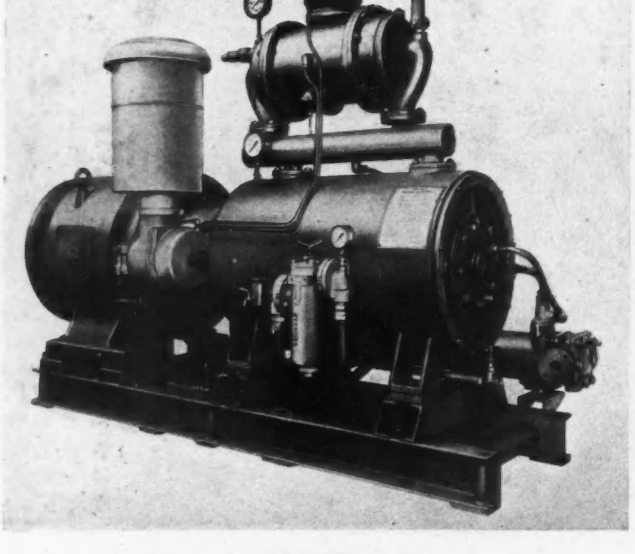


Fig. 70—Two-stage, oil-cooled rotary air compressor—Worthington-Simpson

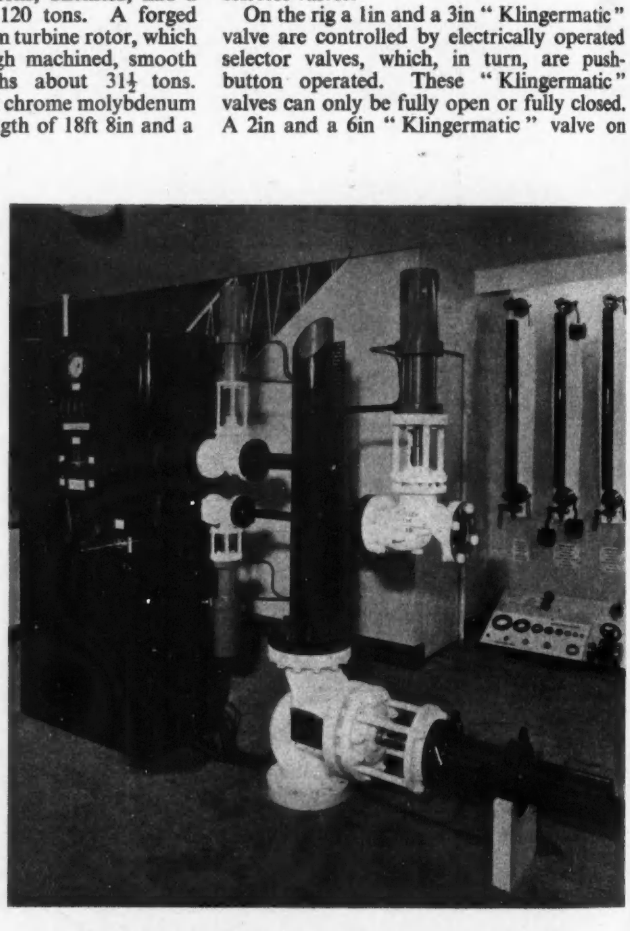


Fig. 71—Working exhibit of four sizes of " Klingerflow " piston valves with the hydraulic pump and control panel—Klinger

the rig are manually selected by levers forming part of another selector valve, and the movement of the hydraulic cylinders is regulated by the control valve. The two smaller valves can both be operated at the same time with either the 6in or 2in valve, i.e. three valves working at the same time. In one line to the 1in valve a double restrictor valve is inserted to control the speed of operation of the hydraulic cylinder.

In the lines to the 6in valve two "Hydroloc" valves are inserted so as to provide positive hydraulic locking for the piston of the cylinder to hold it in any desired position. In no way can the piston be moved by an external force, but it is free as soon as fluid pressure is applied by the operator.

The firm's latest type RTA 28 level gauge which was shown is suitable for boiler pressures up to 2000 lb per square inch, and makes use of the different refractive index between glass and water or steam or air to provide a positive distinction between the steam and water spaces in the gauge. In the RTA gauge two flat plate glasses have parallel surfaces so offset that the line of sight through the gauge is not perpendicular to them. The line of sight from an observer is, therefore, diverted to a greater extent when passing through the vapour space than when passing through the water and the two emerging lines strike contrasting surfaces in the illuminator fixed at the back of the gauge. These surfaces can either be red and green opalescent glass or a white glass screen and darkness.

Standard Telephones and Cables, Ltd.

An interesting selection of its resistance, gas and high-frequency induction heating equipments shown by Standard Telephones and Cables, Ltd., Footscray, Sidcup, Kent, included two new machines. One of these was a rotary gas machine for rapid soldering, brazing, annealing and hardening of parts using sliding holding fixtures on a twelve-burner, single-station model, or forty-eight burners on a larger two-station model. The other was a special equipment which has been developed by soldering or brazing of armature conductors to commutators.

The armature soldering equipment is fitted with a high-current air-cooled transformer which has an output from 2½kVA to 30kVA, and converts normal mains voltage to a safe low voltage which is applied to a pair of water-cooled metal electrodes mounted on the ends of two water-cooled copper bars.

The electrodes are brought into contact with the commutator bar by hand-valve-actuated air cylinders and heating is initiated by foot switch control. The high current which passes through a small section of the commutator bar and the resistance of the specially tipped metal electrodes causes rapid local heating of the joint area. A process timer switches off the current at the end of the preset heating cycle.

If the joints are to be made with soft solder or silver solder of low melting point, the electrodes are brought down to the commutator bar adjacent to the slot and an appropriate gauge of solder wire, containing a non-corrosive resin-based flux, is applied by hand to the joint. For brazing, since both the conductors and the commutator bars are invariably made of copper, a phosphorus-bearing silver solder is used and this requires no flux. Where possible, this silver solder in foil form is prepositioned around the conductors in the slot. One electrode is then brought down on top of the riser and the other at the back of the commutator bar adjacent to the riser. It is stated that

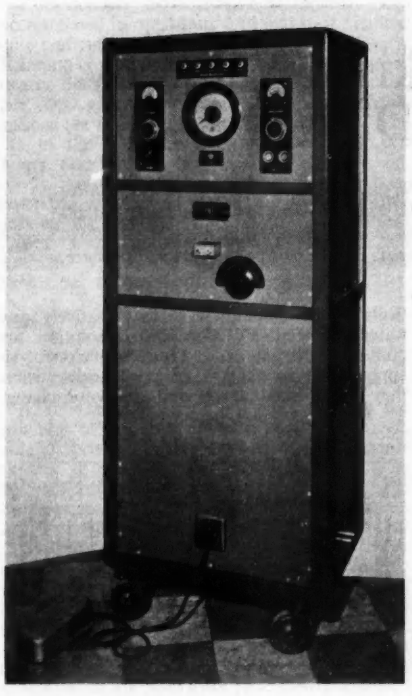


Fig. 72—Induction heating generator with a continuous output of 7kW at a nominal frequency of 400 kc/s. It has a variable output transformer for load matching and control—Standard Telephones

heating times by this resistance method are reduced to 0·75 to 1·5 seconds per segment and equipments are available for commutators ranging from ½in to 10in diameter.

For high-frequency induction heating the firm has introduced four new generators having power outputs of 1kW, 3kW, 7kW and 15kW; the generator with a continuous output of 7kW at a nominal frequency of 400 kc/s is illustrated in Fig. 72. These generators can be supplied with a number of accessory units for supporting workpieces in the inductor coil. Accessories include a work desk with a built-in quench sink, process timers and electromagnetic valves for controlling air and water quenching. An indexing and lifting table available incorporates a selector switch which changes its angular displacement, and, if required, it can be continuously rotated.

United Steel Companies, Ltd.

All the steelmaking branches of the United Steel Companies, Ltd., were represented by typical products which ranged from steel plates for shipbuilding to rings for large bearings, from high-tensile steel strip for concrete reinforcement to valve springs, and from rails and permanent way fittings to heavy ingot moulds.

There were several forms of "Orkot" synthetic-resin bearing for heavy duty in steel rolling mills, which has been developed by the United Coke and Chemicals, Company Ltd. These reinforced plastics bearings, are designed primarily for water lubrication, and tests in service have shown that their working life is considerably longer than those of the commonly used materials. Comparative tests with conventional bearings in one mill showed that the plastics bearings rolled five times the tonnage, cost nearly two thirds less per ton of material rolled, reduced power consumption; the annual bearing renewal cost was reduced from £1034 to £410. A new plant for the manufacture of these bearings to order, is now in production.

Asea Electric, Ltd.

One of the two welding machines shown by Asea Electric, Ltd., Fulbourne Road, London, E.17, is illustrated in Fig. 73. This automatic flash welder is designed for welding steel pipes having a minimum wall thickness of 0·168in and outside diameter up to 5·25in. It is rated 150kVA at 50 per cent duty cycle rating, the maximum welding input being 346kVA and the minimum 41kVA, twenty steps being provided for current regulation. The hydraulic system provides a maximum upset pressure of 12 tons and a maximum clamping pressure of 18 tons.

The machine has a flat top and horizontal clamping equipment for the tubes. For thin-walled tubes which cannot withstand full clamping pressure stops can be fitted on this table, and the clamping pressure is readily adjustable to suit the class of tube being handled.

An internal flash and upset reduction device operates automatically during the welding operation. An automatic welding control process enables the length of the work after welding to be predetermined and the depth and structure of the weld to be kept uniform.

(To be concluded)

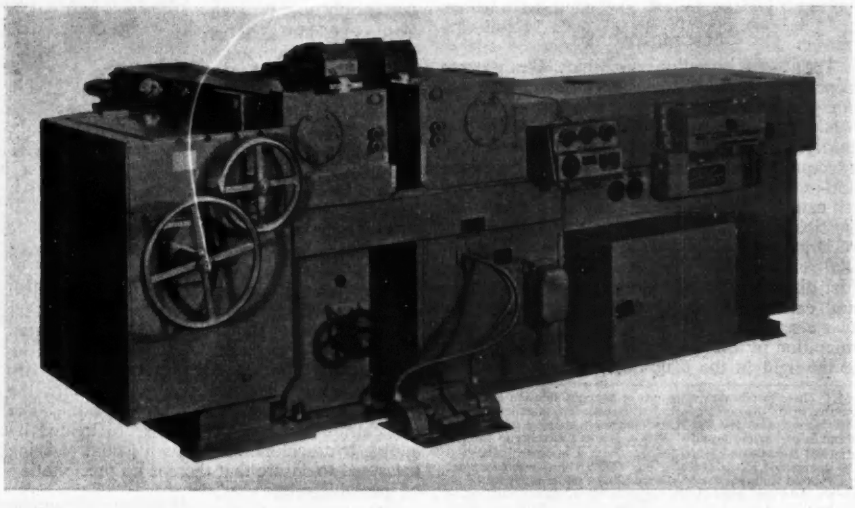


Fig. 73—Automatic flash welding machine for tubes up to 5½in outside diameter—Asea

Purifying Brackish Water by Electro-Dialysis

In our last issue we described a prototype plant developed in the United States for purifying brackish water by electro-dialysis. A plant using the same process has also been developed in this country, and is to be installed at Tobruk, in Libya, where it will purify about 40 tons of water daily. The British plant is described here.

A PROMISING stage of development has now been reached in research aimed at cheap, large-scale purification of saline water by the process of electro-dialysis. The process can now be applied economically to the purification of brackish water, or to reducing the salt content of sea water, if that should be required for some industrial use. But for treating sea water to the extent of rendering it potable, distillation at present remains the most economical method. There is, however, an important range of application for the electro-dialysis process, since brackish waters are found in many areas which are otherwise "arid." Future research is likely to extend the economic range of treatment, as may be inferred from the ensuing description.

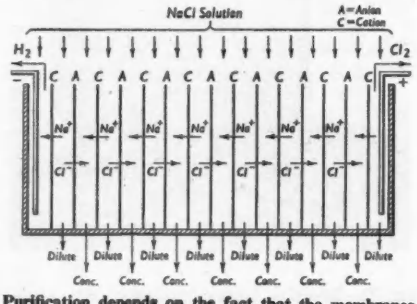
Attention to the problem of purifying salty water has been stimulated in recent years by the activities—or indirectly by the royalties—of the oil companies in the middle east, and also by the United Nations. An example of a large-scale distillation plant was described in this journal on June 1, 1956. As for the more novel process of electro-dialysis, only last week we published an account from our American editor of a plant of this kind developed in the United States.

On September 5 we were invited to a demonstration of a similar plant developed in this country, which might be described as a prototype on the industrial scale, which is similar in many respects to its American counterpart. Since our earlier article went into some detail over costs of operation, and other technical matters, a comparison between the two plants can readily be made, and some points of difference will be particularly noted below.

The plant which we now describe has been made by William Boby and Co., Ltd., of Rickmansworth, Herts, and has been developed by that firm in conjunction with the Chemical Research Laboratory of the D.S.I.R. and the Dutch Central Technical Institute (T.N.O.) of the Hague. The plant was commissioned by the Libyan Public Development and Stabilisation Agency and is to be installed at Tobruk. It is the first practical achievement resulting from the work of an O.E.E.C. committee which has been studying the general problem of de-salting water for some years. Results of Dutch work already carried out were put at the disposal of the committee, and development proceeded from that stage in the hands of the two British concerns named above.

Electro-Dialysis

The basic invention on which the process depends is that of ion-permeable membranes. Ion-exchange resins are well known in chemical work, and are used, on a laboratory scale, for purifying water, and an industrial water-softening process using ion-exchange is also well known. Ion-exchange resins selective for either anions or cations are available, and it has proved possible to manufacture them in the form of large membranes.* The process of electro-dialysis is thus fundamentally as shown in the first diagram. Membranes permeable to anions and cations respectively are arranged between two electrodes. When electrolysis commences, migration of ions (cations to the left and anions to the right in the diagram) is controlled selectively by the membranes, so that relatively pure water and relatively concentrated solution are built up in alternate cells. Products of electrolysis appear only in the two electrode cells, where they are washed away, and the ion-exchange membranes are regenerated by the electrolysis. Thus, by separating the flow from alternate cells, two effluents, one "pure" and one "salty" are obtained.



Purification depends on the fact that the membranes marked *C* are permeable to cations only, and those marked *A* to anions only. When a potential difference is applied at the electrodes, concentrated and diluted solutions build up in adjacent cells

Flow-Cycle of "Batch" Process

Economy in cost is essential for success with a plant of this kind. There is thus considerable ingenuity shown in developing the laboratory process explained above into a cheap and reliable plant of large capacity. The flow-diagram for the plant is shown in the second diagram. The principal difference from its American counterpart is that a "batch" of water is treated and brought to the required degree of purity; the American plant operates with continuous flow, and water passes only once through the electrolysing chamber.†

Raw water is fed into one of the two tanks labelled "diluate," and the capacity of one of these tanks constitutes a batch for treatment. The tank marked "concentrate" corresponds to the salty water separated into alternate cells in the process; it is diluted with raw water from time to time, to keep its solution strength within prescribed limits, and it drains to waste. Notice that water for rinsing the cathode is also circulated to and from this tank. Water for rinsing the anode, labelled "sea-water" on the diagram, runs to waste. This sytem of rinsing suits the particular site conditions at Tobruk. The concentrate and catholyte flows are treated by adding hydrochloric acid, this pH control being measured to ensure that there is no precipitation of insoluble salts.

Operation is such that a "batch" of diluate from one tank is recirculated, as many times as are necessary, until the stipulated degree of purity, as registered by the conductivity cell, is reached. The "pure" diluant is then run off to the supply, and the plant continues operation with the second diluant tank. Adjustment of concentrate strength, change of diluant tank, and all operating controls, are arranged to give, in effect, a continuous process and can be automatic.

It is claimed that all the virtues of a continuous flow are thus achieved, but by actually "batching" the diluate, considerable advantage accrues. In single-pass treatment, for instance, electrical conditions vary considerably across the length of a membrane, since saline water enters at one end, and purified water flows from the stack; the purified effluent is then bled off at a point on the power curve where efficiency is low. By recirculating, much more even conditions are obtained. Further, there is complete operational flexibility (this was especially important in the pilot plant), so with adequate instrumentation, voltages and flow rates can be varied as required to give the most economical treatment. It is claimed that the head loss across the plant and the power consumed, can both be kept to a minimum by this method.

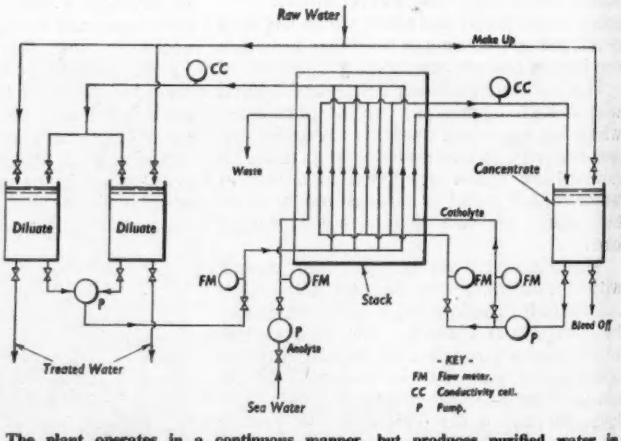
Research has shown that there is a critical velocity of flow for given conditions below which treatment is retarded. Polarisation results in a layer of purified water forming next to the membrane, when this velocity is not attained, and hence in a high electrical resistance. The membranes are separated (the distance between adjacent membranes is 1·3mm) by a perforated and corrugated sheet of plastic material, which induces turbulence in the flow, and helps to keep the critical velocity low.

Construction of Plant

The ion-permeable membranes of the plant consist of ground ion-exchange resin and polythene, sintered and calendered. These membranes are considered satisfactory except that they are delicate and cumbersome to handle, and more satisfactory membranes are being developed to give improvements in mechanical strength and also in electrical conductivity. Similarly, a cheaper separating material, plastics in the familiar form of "expanded metal" is to be used between them.

The plant to be seen at the demonstration comprised a "stack" of fifty membranes, mounted in a steel frame as shown by the illustration herewith. Note that the anode frame is adjusted by three hydraulic jacks and finally held by bolts. The pipework is of polythene, the various tanks (which are not shown) being to the left of the membrane stack.

Each membrane is a rectangular sheet, with a hole in each corner. The stack is built up by placing the separating and stiffening sheet between membranes, and by placing various kinds of plastics washers over the four holes.



The plant operates in a continuous manner, but produces purified water in batches. Raw water is introduced into one of the diluate tanks, and then recirculated until purified

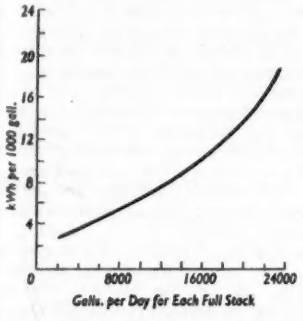
* "These membranes when put in aqueous solution are comparable with dissociable salts, with one ion attached to the membrane frame and the other oppositely charged ion moving about freely in the liquid. With a positive membrane the ion attached is positive, e.g. $N(CH_3)_3^+$; with a negative membrane the unattached ion is negative, e.g. COO^-. Now when ions are transported via the pores of the membrane under influence of an electric field the ions with the same charge as the mobile ions of the membrane are let through and the velocity of the oppositely charged ions is diminished."—Abstract from an article by S. G. Weichers and C. Van Hoek, *Research*, May, 1953.

† A two-stage plant with two chambers is also used.

Some of these washers are "blind" and seal the hole; some are corrugated and allow water to flow into or out of the cell. Flow is arranged to take place diagonally across the membranes, so that diluate and concentrate can be introduced at the lower two openings, and extracted at the top. Separate pipework carries the water for rinsing the electrodes.

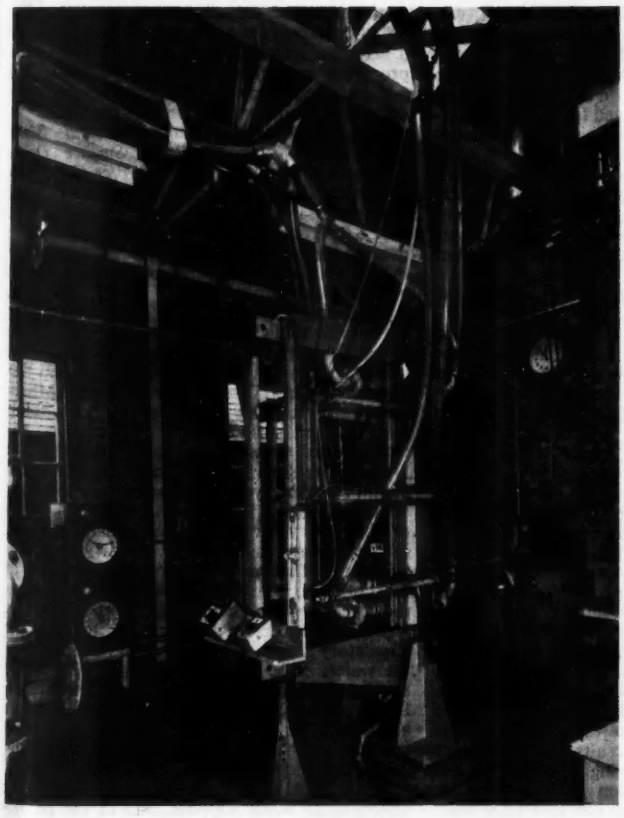
Operation

The economic range of operation of the plant is stated to be from a maximum total dissolved



Power consumption for a "stack" of 200 membranes. Water with a salt content of 4600 p.p.m. is purified to a content of 500 p.p.m.

solid content of 10,000 parts per million, purified to 500 parts per million. The capacity of a stack of fifty membranes is about ten tons per day; the graph shows power consumption against output for a stack of 200 membranes and for the Tobruk water which it will purify. Up to 400 membranes can be built into a stack. The head loss across the fifty-membrane stack demonstrated was stated to be about 4ft, and the diluate is recirculated between five and ten times in an hour. Between 65 and 80 per cent of the output of the brackish source is reduced to potable purity by the plant. The maximum potential difference employed is 217V.



A "stack" of fifty membranes arranged as a laboratory pilot model to purify brackish water as found at Tobruk

Considerable experience has already been accumulated in operation, and figures for capital cost and running costs are given by the makers. Running costs for the Tobruk plant (salt content nearly 5000 p.p.m.) are quoted at about 5s. per 1000 gallons. A plant for treating 10,000 gallons per hour would cost about £80,000. The life of the membranes is estimated at 12,000 hours, and the membrane cost at about 1s. 6d. or 2s. per 1000 gallons treated. Power consumption varies from 7kWh to 25kWh per 1000 gallons for the d.c. consumption plus about 2kWh for the a.c. consumption in pumping and so forth. The Tobruk plant is to be run at about 7kWh per 1000 gallons d.c. consumption.

Cross-Channel Cable Approval

Approval in principle has been given by the Minister of Power to the proposal to provide a high-voltage connection between the supply system of the Central Electricity Authority and of Electricité de France. The main items of the connection as now planned will include a 275kV overhead line between a substation at Canterbury and a terminal point near Dungeness, a converter station at the Dungeness terminal point where alternating current at 275kV will be converted to direct current at 200kV, a single submarine cable between the Dungeness terminal and a converter station east of Boulogne for conversion of direct current at 200kV to alternating current at 225kV with a connection to the French 225kV system. The submarine cable connection and the associated terminal equipment will have a nominal transmission capacity of 160MW in either direction.

As previously announced, the choice of d.c. cable for the link between the two systems has been made because with direct current the power transfer is much more easily controlled than with alternating current and is virtually independent of the frequencies of the two systems. Besides the d.c. connection is more economic than the a.c. connection as originally proposed, and the single d.c. cable is expected to be less prone to fault than an a.c. circuit of three cables plus a spare cable when laid across the English Channel where the risks of damage due to external sources are considerable.

The plant required for the terminal stations of the connecting link consists, first, of conventional plant, such as switchgear, transformers and power factor correcting equipment which will be supplied by both Great Britain and France, and, secondly, converter plant, of special design. It is considered at the present time that the only organisation with the necessary experience to build the converter equipment at present is the Swedish company, ASEA, which has successfully completed and operated the link between the Swedish mainland and the Island of Gotland. It may be recalled that this link consists of a 62-mile length of single-core cable with sea return. The converter equipments consist essentially of two banks, each of six mercury arc valves, the banks being connected in series to give 100kV terminal voltage. Basically similar arrangements are used for the converter equipment on the mainland (where the a.c. supply at 132kV is converted to direct current at 100kV and fed into the single-core cable) and for the inverter equipment on the island where the direct current is "inverted" to alternating current at 30kV. The system is designed for two-way transmission of power.

This cable is laid in an east-west direction. The Channel cable, however, will be laid in a north-west–south-easterly direction and it is thought that a single-core cable with sea return would cause deviation of the magnetic compasses of ships passing over it and along it and might also give rise to corrosion trouble in communication cables laid in the vicinity. To avoid these difficulties, the cross-Channel cable will employ two insulated conductors to form a "go" and "return" circuit.

The route originally considered for the submarine cable was from a point near Dover to a point between Calais and Cap Gris Nez, but although it is shorter than the route now selected it involves crossing some communication cables at an acute angle and is considered to be more subject to interference from external causes.

Half of the cable (which will be approximately 35 miles long) will be made in Britain and half in France. Inquiries have been sent to the principal cable manufacturers in both countries and tenders are now being examined. It is probable that the d.c. system will have mid point earthing: the operating voltage of the cable will be 200kV between conductors, which will operate, respectively, at 100kV above and below earth potential.

Whereas in the earlier a.c. scheme for this cross-Channel connection it had been decided that the most suitable cable would be a gas-filled paper-insulated cable, the proposal to use a high-voltage d.c. scheme with a maximum potential of 100kV to earth suggests the possibility of using a "solid" paper-insulated cable or a polythene-insulated cable. The latter offers prospects of greater simplicity and reduced cost, but further experimental work will be required before this material can be used for high-voltage working and before a firm contract can be placed.

Further consultation will be necessary with other bodies such as the Post Office organisations and the maritime authorities before the plans can be finalised, the route settled in detail and work started on site. Unless there are serious unexpected difficulties it is hoped that the project can be completed in time to assist with the winter load conditions of 1960-61.

The total cost of the scheme (between the two terminal points and excluding the extensions required to the systems up to these terminal points) is about £4,000,000. The British share of the expenditure for the interconnection will be more than offset by the saving obtained through reduction of the amount of generating plant installed. Similar savings will be effected in France, although it is more difficult to assess them accurately because of the mixed character of the hydro-electric and steam-electric generation. Besides the capital savings there will be savings from operational energy exchanges between the two countries and it has been estimated that there will be an overall economy upwards of £300,000 per annum.

The economies to be obtained will depend largely upon experience with the flexibility and reliability of the connection and with methods of co-ordination as between the control centres of Britain and France. An analysis of the economic aspects of a cross-Channel cable link was given in an I.E.E. paper by Sayers, Laborde and Lane (The Engineer, April 2, 1954). This analysis remains valid in principle although the authors' conclusions would have to be modified quantitatively to take account of altered price levels and the change in concept from a three/four cable a.c. link to a single d.c. cable.

Miniature Double-Pole 10A Toggle Switch.—A miniature double-pole switch rated at 10A, 250V, a.c. only has been introduced by Arcolectric (Switches), Ltd., Central Avenue, West Molesey, Surrey. It is a microgap switch with silver contacts in a moulded case which measures about 1in by 1½in by ½in overall and is suitable for back-of-panel mounting.

International Conference on Radio-Isotopes

THE International Conference on Radio-Isotopes in Scientific Research, convened by U.N.E.S.C.O. under a resolution of the General Conference at its ninth session, is now being held at the Faculty of Medicine in Paris. The opening session took place at the Sorbonne on September 9, and the conference will continue until September 20. A selection of papers likely to interest engineers is abstracted below: the full proceedings are to be published in due course under the auspices of U.N.E.S.C.O.

Structure and Wear Resistance of Case-Hardened Steel. L. S. Palatnik, I. M. Lyubarsky, and A. P. Lyubchenko (U.S.S.R.).—The wear resistance of case-hardened steel is determined by its "fine" structure, i.e. the phase composition (revealed metallographically), dispersion, block structure, microtensions, mode of conjugation between like and unlike lattices, distribution of alloying elements, and so on. The radioactive tracer method, in combination with other procedures, is very sensitive in the investigation of "fine" structure, and yields important data. The method was used to examine specimens after heat treatment of various kinds, and it was established that, besides the diffusion of carbon, the case-hardening process involves a back diffusion of metal atoms to the surface of the specimen resulting in an elevated vacancy concentration in the crystal lattice. The rate of cooling greatly affects the "fine" structure of austenite, and the saturation of the carbides and the solid solution (γ, α) with alloying elements, as well as the distribution of carbon in the austenite over the cross-section of the case-hardened layer. Rapid cooling results in a wear-resistant structure containing up to 90 per cent residual austenite, the crystal lattice of which undergoes comparatively uniform micro-deformation with practically no breakage of its mosaic blocks. Slow cooling leads to considerable breakage of mosaic blocks in the relatively less alloyed residual austenite, and to non-uniform micro-deformation of the γ-lattice. Such a "fine" structure cannot be corrected by ordinary methods of heat treatment such as hardening, tempering and freezing. The same structure results also after a very long period of wear in specimens with a "healthy" initial structure.

Labelling and Tracing Sand and Pebbles in Investigations of Littoral Drift. D. B. Smith and J. D. Eakins (U.K.).—The use of radioactive tracers for the study of silt, sand and pebble movement is becoming an established technique. A wide variety of materials has been used, including labelled ground glass. A technique is now employed to label the surfaces of sand particles and hard pebbles by adsorption of a suitable layer, followed by baking to stabilise the material. A number of metallic elements of high cross-section has been investigated, and material appropriate for use as a tracer has been prepared. Carrier-free barium-140 separated from its daughter lanthanum-140 can be used. In an experiment using flint pebbles labelled with barium-140, a portable scintillation counter enabled beach movements to be followed for six weeks. Location of several per cent of the number of pebbles originally used was possible for about a month, during which time movements of over half a mile were measured.

Effect of Surface Conditions During Wear of Tungsten Carbide. J. Golden and G. W. Rowe (U.K.).—The wear on activated tungsten carbide sliders has been studied experimentally. Active fragments detached in sliding can be assessed quantitatively by use of a scintillation counter or by autoradiography. Calibrated micro-densitometer records are employed to locate and measure about 10^{-12} grammes of tungsten carbide on a millimetre of track. Where the wear is smooth, this corresponds roughly to a layer six Angstrom units thick. A simple apparatus produces long spiral tracks on a flat disc, and at the same time measures the forces involved. By dividing the disc into segments, each differently treated, it is possible to obtain ten or more independent determinations of wear rate in a given segment during a single run. It is found that the wear rate is adjusted to its equilibrium value in a very short distance, and that this value is reproducible in any one segment. The results show that the wear is very much dependent upon the mechanical and chemical state of the surface. It is seen, for example, that scratches left by 20-μ abrasive papers on copper discs can cause sudden sharp increases in wear. Residues left by ammoniacal etching increase wear, while those left by aqueous hydrochloric acid decrease the wear, even after careful washing. Standard preparation techniques, such as benzene or alcohol degreasing, are found to leave contaminant films which reduce the wear. When polished, tungsten carbide wears more smoothly but more heavily than when etched. Oxide films increase the wear on copper, and there appears to be a direct relationship between the thickness of oxide film and the wear rate. On nominally clean copper the wear is nearly proportional to the friction force.

Non-Metallic Inclusions in Steel Ingots. Tunezo Saito, *et al* (Japan).—Pouring refractories, which are the fertile source of inclusions, were impregnated with radioactive isotopes Ca-45 as CaO and Zr-95 as ZrO_2. Mild steel was melted and refined in a 150kVA Héroult furnace, tapped into the tagged ladle and an ingot of about 90 kg was obtained. Non-metallic inclusions extracted from the ingot, ingot scum, slag and all other radioactive products were collected, weighed and counted. In the light of these treatments, the behaviour of the eroded refractory materials carried along by the pouring stream was quantitatively traced with the following results: when nozzle, stopper and fireclay mortar were tagged (pouring temperature: 1550 deg. Cent.), 69·7 grammes of the tagged parts were eroded, 5·63 per cent of which were transported into the ingot case; 56·4 per cent of the transported refractories were refloated as ingot scum, and the rest (43·6 per cent) was retained in the ingot as non-metallic inclusions. The ratio of the non-metallic inclusions of tagged refractory origin to the total inclusions in the ingot was 2·86 per cent. When all the refractories of the ladle were tagged (pouring temperature: 1550 deg. Cent.), inclusions of refractory origin amounted to 8·74 per cent of the total content. The behaviour of the eroded refractory materials was found to depend on pouring conditions. For instance, when pouring temperature increased, the erosion became stronger, a larger amount of material floated as ingot scum and a cleaner ingot was obtained.

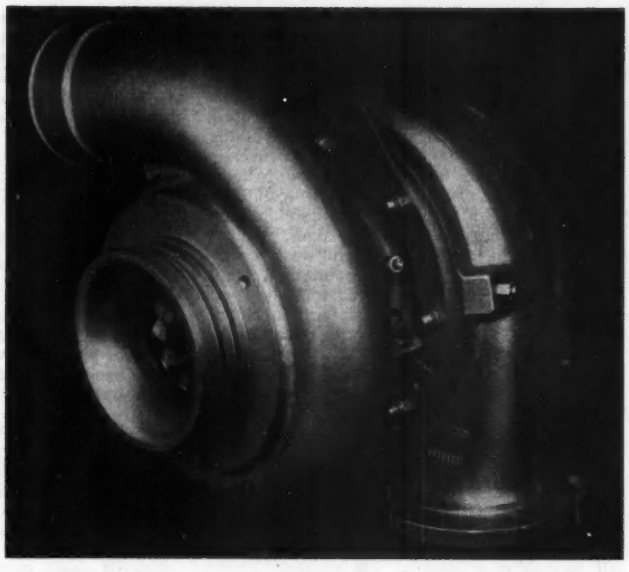
Assessment of Quality of Refractory Materials Used in Casting Pit, and Distribution of Non-Metallic Inclusions in Steel. Tadeusz Malkiewicz, Roman Wusatowski, *et al* (Poland).—An attempt has been made to investigate the distribution and amount of non-metallic inclusion originating from refractories used in the casting pit by means of radio-isotope Fe-59. The radio-isotope in the form of Fe_2O_3 was introduced into the fireclay batch used for brick making. Ingots and blooms of steel for deep drawing were investigated by autoradiographic methods and measurement of radiation intensity. For comparison of different refractories used for runner bricks, two ingots were poured in each runner. The investigations showed that, regardless of the kind of refractories used in a given mould and hot top, the non-metallic inclusions originating from runner brick remained mostly in the body of the ingot remaining after discarding crops. Runner bricks with the lowest refractoriness gave the most uniform distribution of inclusions along the ingot and the lowest mean radiation intensity. The poorest results were obtained with runner bricks having the highest refractoriness. The pattern of distribution of inclusions in the ingot had the form of a paraboloid in the head of the ingot with shape similar to solidification isotherms. In the ingot butt another shorter paraboloid with its vertex towards the top of the ingot was observed. The examinations of the fractures of blooms showed that the radio-active inclusions were mostly distributed in a zone up to 7mm below the surface. The depth of this zone increased towards the top of ingot.

Solubility of Low-Volatility Substances in High-Pressure Steam. M. A. Styrikovich (U.S.S.R.).—The solubility of a number of compounds in steam is of great importance for the genesis of rocks, and for the work of steam power stations based both on organic and on nuclear fuel. However, up to recently, investigations of solubility were carried out by conventional chemical analysis which could not ensure reliable qualitative results when the solubility was at the accuracy limit of the method employed. The use of radio-isotopes has been found very effective, and has made it possible to determine accurately very small concentrations of dissolved substances (down to 10^{-5}mg/kg). The use of this method has permitted several generalisations. In the U.S.S.R. a study was made of the distribution of a number of substances between the water and steam phases depending on the pressure and concentration. The solubility of a number of substances, namely, NaCl, Na_2SO_4, $CaCl_2$, $CaSO_4$, $CaCO_3$, $Ca(OH)_2$, in the system solid-steam was also investigated at sub-critical pressures, and in the system solid-water at supercritical parameters (up to 300 atmospheres and 650 deg. to 700 deg. Cent.). These investigations, together with the results of studies carried out in the U.S.A., have made it possible to plot state diagrams for a number of systems (e.g. H_2O-SiO_2; H_2O-NaCl; H_2O-Na_2SO_4; H_2O-$CaSO_4$), embracing both the regions of the liquid and steam phases at sub-critical pressures, and the region of super-critical pressure. In the course of the investigations, hydrolysis of salts by superheated steam was detected at temperatures as low as 550 deg. to 600 deg. Cent.; in the case of NaCl, this process has been studied qualitatively.

Fluid Density Measurements in Enclosed Systems. J. F. Cameron (U.K.).—In measurements of the density of fluids in enclosed systems, nucleonic thickness gauging methods find many applications. As no contact is required with the fluid, such measurements can conveniently be applied to systems at high temperature and pressure, and to corrosive, inflammable, toxic or otherwise dangerous fluids. An outline is given of the theory of the selection of the appropriate radiation energy for a homogeneous fluid and for a heterogeneous fluid in a container. Relevant properties of different radiation detectors are outlined, and some practical considerations are discussed. Some applications are described.

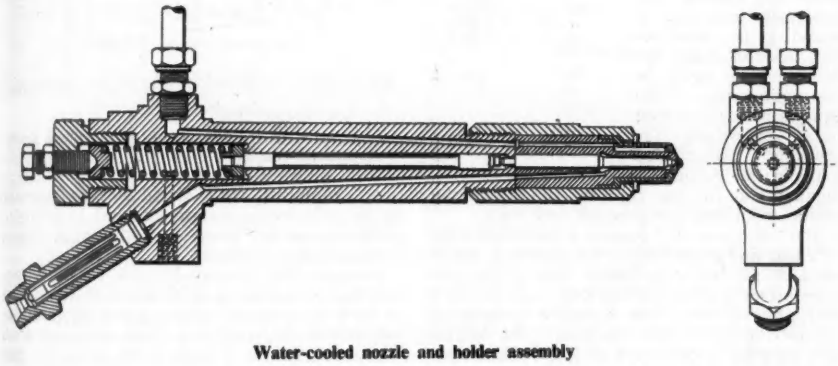
Continental Water Balance, Ground Water Inventory and Storage Times, Surface Ocean Mixing Rates and World-Wide Water Circulation Patterns. F. Begemann and W. F. Libby (U.S.A.).—The man-made tritium produced during the Castle Operation in the spring of 1954 has been used to study the circulatory rates for waters in the Northern Hemisphere, particularly in the northern Mississippi Valley of the United States. It is observed that Northern Hemisphere rains six months to eighteen months following Castle had about half the tritium content that the surface water had, and this difference has revealed that about one-third of the rain in the Upper Mississippi Valley is ocean water, and about two-thirds re-evaporated surface water. This allows the total inward transport of ocean water for the Upper Mississippi Valley to be calculated. It is about 1·0m per year. It has been found that, on the average, tritium has a residence half-life of about six years on the continental land mass of North America (radioactive decay taken into account). This probably will be applicable to most other continental land masses. Water from the oceans stays in the northern Mississippi Valley fifteen years on the average. Studies of the circulatory pattern of hot springs have shown that the waters of several hot springs are rainwater that has been stored for relatively brief periods. Study of groundwaters has shown that in large areas the water issuing from wells dug for normal use is older than fifty years. It appears that the technique of studying the tritium content of well water is quite likely to be of value in studying underground water supplies, and in the prediction of their susceptibility to drought as well as depletion by pumping, and the possibility of replenishment from rain or snow.

Diesel Engine Equipment

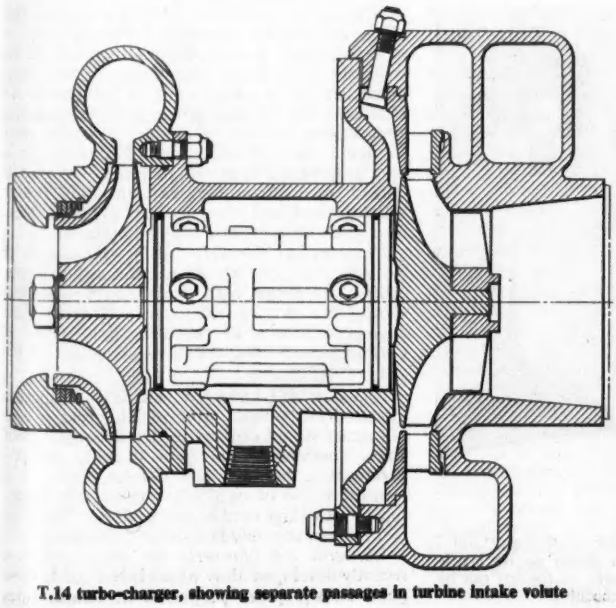


At this year's Engineering, Marine, Welding and Nuclear Energy Exhibition two items of equipment illustrative of the increasing demand for economy and high specific output from the oil engine made their first appearance, one a turbo-charger of notable compressor efficiency and the other an injector nozzle with provision for water cooling. The turbo-charger has already a history of service on earth-moving plant of United States manufacture.

THE conventional jerk-pump fuel injection system supplies to the nozzle only as much fuel as is to be injected, and the fuel is subject to degradation by heat while in the nozzle, resulting in needle sticking or other adverse effects. As a counter to this tendency, there has recently been introduced by C.A.V., Ltd., a nozzle with provision for internal water cooling, which it is expected will be advantageous not only when burning Class "C" fuels, or in dual-fuel engines consuming very little oil, but also in engines which are running at or over 160 lb per square inch brake mean effective pressure. The new nozzles are available in sizes "T" and "U"; the diameters of the nozzles are the same as on normal components, and the nozzle holders can be made correspondingly shorter to enable the assemblies to be dimensionally interchangeable. The construction of the injector can be seen in the accompanying diagram: the cooling passages will pass up to 60 gallons per hour and are nickel-plated to avoid corrosion.



Water-cooled nozzle and holder assembly



T.14 turbo-charger, showing separate passages in turbine intake volute

While the exhaust-turbine-driven supercharger may be regarded and even operated as a gas turbine, a significant difference to the designer is that, while on the prime mover increases in mechanical and turbine efficiencies are more valuable than corresponding improvements in the compressor, on the pressure charger of an engine with a fixed volumetric capacity the opposite is true. This explains the appearance, on the stand of Rotol Ltd, of the AiResearch turbo-charger, distinguished by a fully shrouded impeller and by the use of plain bearings. These units are at present built by Rotol in four sizes, T.7, T.10, T.14, and T.30, handling respectively 10-30, 15-45, 20-60, and 25-110 lb per minute, which differ in detail as well as in output. The unit shown in the photograph reproduced above is the T.30, which can aspire 900 cubic feet per minute and give a density ratio of 1·5 with a pressure ratio of only 1·85, at a compressor efficiency less than the peak of 85 per cent. The same density ratio calls for a pressure ratio of 2·0 from the T.10, which has an unshrouded impeller with a peak efficiency of 70 per cent, when handling 410 cubic feet per minute. These performance figures are continuous ratings, involving rotational speeds of 42,000 and 60,000 r.p.m. respectively. The maximum loadings of the two units are 45,000 and 65,000 r.p.m. respectively. Although these turbo-chargers have already been adopted for engines built in this country by Rolls-Royce (see page 769, May 17, 1957) and Caterpillar, the T.1404 being used on the D.8 engine, no performance figures for blown engines have yet been made available to us. Of particular interest, however, is the fact that AiResearch offers a version of the T.10 with a waste gate by-passing the turbine to enable peak torque to be obtained at a low mass flow, and that similar systems are to be used in this country for the T.14 on Rolls-Royce and Caterpillar engines.

The construction of a typical unit is shown in the accompanying drawing. Shrouded or unshrouded impellers are light alloy precision castings: the compressor casing is also light alloy, but the turbine casing, which supports the entire assembly, is of Meehanite. To enable the rotating assembly to be balanced after being finally built up—c.g. positions are held within 0·0002in for individual parts and on dynamic balancing—the bearings are carried in a removable cage of cast iron (this is not a feature of the smaller blowers). The bearings are of aluminium bonded to steel, and a separately filtered supply of oil from the engine is fed to them. The oil drains back by gravity: to prevent seepage through the labyrinths, the shaft axis must be within 30 deg. of the gravitational horizontal. An interesting detail is the construction of the glands, which are composed of a sandwich of thin and thick rings.

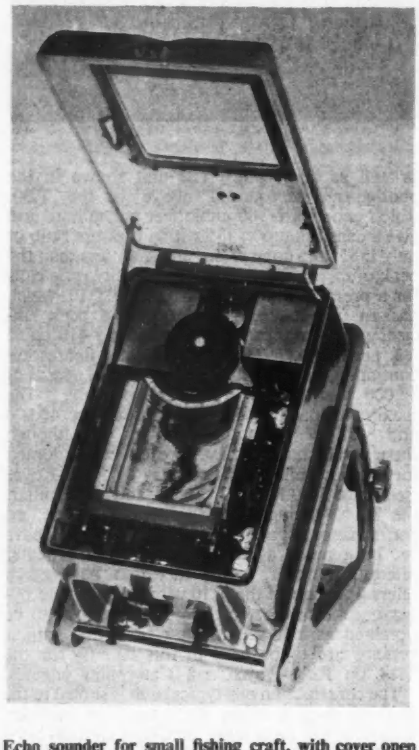
The turbine casings also vary widely. On the larger engines, the nozzle vanes are cast separately, these components being readily interchangeable to match individual engines: the method of retaining them is notably simple, they being wedged by the heads of bolts at an angle less than 90 deg. to the turbine axis, and also serving to lock these bolts against rotation—one such bolt can be seen in the illustration. (Nuts throughout are of a distinctive self-locking design.) While the turbine invariably has a volute entry, the T.14 design has two passages through the attachment flange which remain separate right up to the nozzles, this being essential if pressure pulses are to persist up to the turbine.

It is interesting to note that AiResearch turbines also appeared last week at the display of the Society of British Aircraft Constructors, having been shown by Armstrong Siddeley as aero engine starter motors.

Echo Sounders for Small Fishing Craft

ECHO sounders have been used to good effect for some years by the larger fishing vessels for detecting shoals of fish and determining the area they cover. In order to provide this valuable aid to the smaller open craft normally engaged in inshore fishing, a new echo sounder of reasonably low-cost recording, known as the "MS30," has been developed by Kelvin and Hughes (Marine), Ltd., Knotts Green, Leyton, London, E.10, and was recently demonstrated in the firm's London showroom. This equipment consists of the recorder, shown in the accompanying illustration, and a small transducer which is used for both transmission and reception of signals.

The recorder, which weighs only 50 lb, is of particularly compact design and enclosed in a watertight case with a transparent front through which the chart can be clearly seen. This equipment is fitted on a pivoted base frame which enables it to be mounted horizontally or vertically in any convenient position on a boat. The lid of the case is held by a single catch and is quickly and easily swung open to give access for servicing purposes and renewing the roll of recording paper. To facilitate servicing the electronic and power assemblies are built as separate replaceable units. Power for operating the set can be provided from the standard battery normally employed on the craft for engine starting and other purposes. An automatic voltage controller is fitted which ensures consistent performance of the set irrespective of fluctuations in voltage. The controls for the instrument are on the lower end of the case and protected against damage by a shield.



Echo sounder for small fishing craft, with cover open and showing a typical recording on the paper chart

Either of two transmission pulse lengths can be selected to enable the user to obtain the best results in shallow and deep water and in different types of fishing. Three speeds are also provided for the paper scales so that they can be used with economy and traversed in accordance with prevailing fishing conditions when searching for a shoal or determining its extent. The transducer is in the form of a compact block 8¼in long by 3in wide and 1¼in deep, weighing only 6 lb, and it is designed for easy fitting on the craft.

Three models of this equipment are available—a standard set for use up to 110 fathoms, a shallow water set for use up to 55 fathoms, and a deep water set for use up to 220 fathoms. The paper scales have a nominal length of 45ft and the three chart speeds available with the different models are as follows: standard set, 0·5in, 0·33in and 0·16in per minute; shallow water set, 1·0in, 0·66in and 0·33in per minute; and the deep water set, 0·25in, 0·16in and 0·08in per minute.

Equipment for Producing "Soft" Radiation

WE illustrate the "Raymax 50" radiographic set which has been developed by Newton Victor, Ltd., 132, Long Acre, London, W.C.2, as a means of producing very soft radiation, so that small changes in the density of the specimen can be shown clearly. This result is achieved by the use of a beryllium window in the X-ray tube, transmitting a high intensity of soft radiation when the tube is energised at voltages as low as 5kVp. Because such radiation is readily absorbed and scattered by air, the X-ray tube is provided with a fine focus, permitting the use of short focus film distances without the sacrifice of fine detail.

The "Raymax 50" is intended to be suitable for micro-radiography, as the fine focus and stepless kilovoltage control enable sharply defined pictures of very high contrast to be produced, which can then be photographically enlarged.

Other applications are examinations to determine the authenticity of documents, old paintings, and the examination of grain for infestation; although infested grain shows only slight changes in density from that of sound grain, nevertheless, infested grains can be seen quite easily on the radiographs. The equipment has also been used successfully for checking spot-welded joints in thin-gauge aluminium and for the checking of low-density plastic mouldings for porosity and voids.

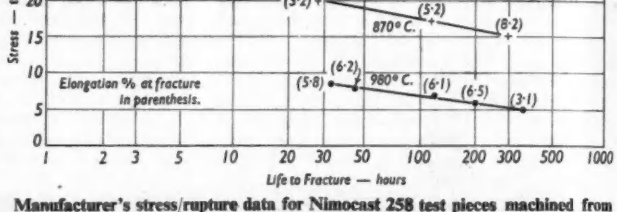
The "Raymax 50" consists of a transformer, tubehead and control box. The tubehead, which includes an h.v. transformer and a filament transformer, is fitted with an X-ray tube having a beryllium window; the complete assembly is mounted in an oil-filled container. The control unit includes a kilovoltmeter and continuously variable kilovoltage control, 0–15 milliammeter, filament control, and filament stabiliser maintaining voltage supplied to the filament constant within ±1 per cent. A synchronous motor exposure timer with indicating lamp is rated from one to fifty-five seconds in steps of one second. The control unit, which is fitted with a carrying handle, can be fixed to a wall or stood on a bench. For some applications it is convenient to mount the tubehead on a small lead-lined cabinet. In other cases a simple tube mounting stand, as illustrated, can be supplied.

"Raymax 50" equipment for producing "soft" radiation. The tube head is shown on its bench-mounted stand. The control unit on the left can be wall or bench-mounted

High-Temperature Alloys for Casting

IT is announced by Henry Wiggin and Co., Ltd., that the name "Nimocast" has been introduced to cover a range of high-temperature nickel-chromium-base alloys for use in the cast form. Six alloys are available in the series, five of which were developed in the laboratories of The Mond Nickel Company, Ltd. The Nimocast alloys are complementary to the Nimonic wrought heat-resisting alloys. In the following notes the earlier names are given in brackets.

Nimocast 75 (*formerly Nimonic C.*75).—This alloy is intended for conditions involving low stresses but requiring good resistance to oxidation. Nimocast 75 is stated not to respond significantly to heat-treatment, and to be normally used in the "as-cast" condition, or after a stress-relieving treatment.



Manufacturer's stress/rupture data for Nimocast 258 test pieces machined from investment-cast bars

Nimocast 80 (*formerly Nimonic CC*).—Nimocast 80, corresponding to Nimonic 80, is claimed to have considerably higher room temperature mechanical properties and creep-resistance than Nimocast 75. It is said to be used for gas turbine stator blades and precombustion chambers of high-performance diesel engines, normally in the fully heat-treated condition.

Nimocast 90 (*formerly Nimonic CB*).—This alloy, the casting version of Nimonic 90, is reported to respond to heat-treatment and to be generally used in the age-hardened condition. Nimocast 90 is thought to be preferable to Nimocast 80 for high-stress, high-temperature applications because of better castability and strength. At 750 deg. Cent., Nimocast 90 is said to show stress-carrying capacity inferior to that of the corresponding wrought alloy, but at 870 deg. Cent. and above, at least as high a stress for a given life is carried as by Nimonic 90.

Nimocast 242 (*formerly C.*242).—Developed by Rolls-Royce, Ltd., for investment casting applications involving high resistance to thermal shock, this alloy is said to be used in the "as-cast" condition at temperatures up to 1050 deg. Cent. for such components as stator blades for gas turbine engines.

Nimocast 257 (*formerly MC.*57).—Properties intermediate between those of Nimocast 75 and Nimocast 90 are claimed, giving adequate proof stress combined with good ductility at temperatures in the range 600–700 deg. Cent. It is thought to be of particular interest for centrifugally cast rings used in gas turbines. The alloy is for use in the fully heat-treated condition.

Nimocast 258 (*formerly MC.*58).—This is a recently developed alloy which is claimed to have good stress/rupture properties at temperatures

higher than 950 deg. Cent. It is similar in composition to Nimonic 100, the most creep-resistant alloy of the Nimonic Series. The reported stress/rupture properties are shown in the accompanying figure. The highest stress/rupture properties are stated to obtain in the as-cast condition.

Gas Turbine Alternator for the Royal Navy

EARLIER this year a gas turbine-driven alternator was installed in the Navy's trials cruiser, H.M.S. "Cumberland," and is the first such unit to be used in a major warship. The original electric supply was 220V d.c. and, to avoid the necessity of raising steam for harbour duties and to conform with N.A.T.O. equipment requirements of 440V, 60 c/s, a.c. supply, a gas turbine-driven alternator set was chosen, the power unit being a standard Ruston and Hornsby mark T.A. gas turbine directly coupled to a Bruce Peebles three-phase alternator.

The machine, which is capable of an output of 900kW and is rated at 750kW for this application, is of simple open-cycle, self-cooled design, burning diesel fuel: it requires only a light seating. Arrangements have been made whereby the compressor blades can be cleaned without dismantling. Sea salt deposits can be washed off with fresh water injected into the air inlet and, similarly, industrial fouling while in harbour can be removed with a paraffin wash. The air intake is baffled to exclude moisture and Heather filters are fitted to exclude dirt.

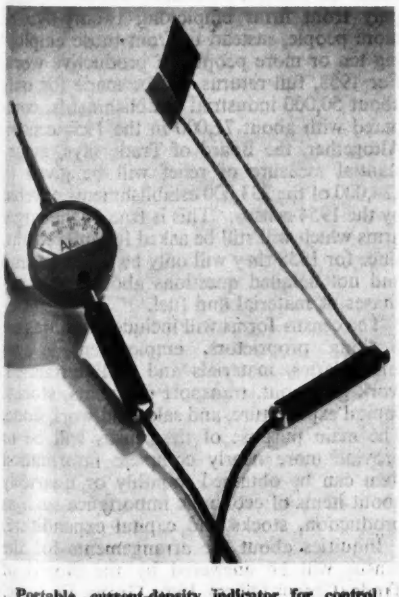
The control requirements were that for load changes of 25 per cent of the rated full load the speed change was not to exceed 2½ per cent, and the momentary voltage change was not to exceed 15 per cent, and was to be restored to, and remain within, ±1 per cent of the set voltage within 0·5 second from the initial change. This specification was met by fitting a Ruston P2 limiter and a B.T.H. Magnestat.

Portable Current-Density Indicator for Electroplating

THE accompanying illustration shows a portable current-density meter made by the English Electric Company, Ltd., Stafford, for use in the electroplating industry. By giving a direct reading in amperes per square foot, this indicator enables the current density in the electrolyte at any point of any number of loaded electroplating vats to be checked rapidly, and their operating currents adjusted to give improved control over the plating operation.

The equipment consists of a robust moving-coil ammeter connected in series with a plate electrode of known surface area. The electrode is immersed in the electrolyte between the component to be plated and the anode. When contact is made to the work bar through the forked spike on the ammeter case, a direct indication of current density in the vat at that point is given on the ammeter dial.

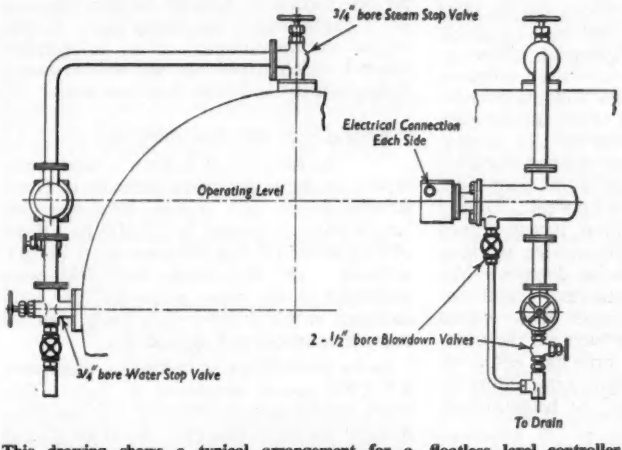
Two electrodes are supplied, one of stainless steel for use in stannate tin, zinc and cadmium vats where current density does not exceed 50A per square foot, and a second glass-backed electrode for use in chromium and bright nickel vats where current density is up to 250A per square foot. Selection of the correct electrode enables readings with an accuracy of ±5 per cent to be readily obtained.



Portable current-density indicator for control of electroplating

Floatless Liquid-Level Controller

HEAT is dissipated more rapidly by a body when it is immersed in relatively cold liquid than in gas or vapour at the same temperature. Also, the coefficient of expansion with temperature differs between metals. These two principles are used in a level controller now available from Meynell and Sons, Ltd., Montrose Street, Wolverhampton.


3/4" bore Steam Stop Valve
Electrical Connection Each Side
Operating Level
2 - 1/2" bore Blowdown Valves
3/4" bore Water Stop Valve
To Drain

This drawing shows a typical arrangement for a floatless level controller on a shell boiler. A similar layout serves when the instrument is used as a low-level cutout and alarm

Two probes in the controller work in opposition. Each probe consists of an Invar rod in a brass tube. The rod is free at one end and connected to the tube at the other end. The dimensional change when temperature alters is much greater with brass than with Invar, and the rods bear on the two ends of a pivoted lever in such a way that the differential expansion or contraction can operate a switch. One of the rods is continuously heated, and the other is therefore always colder. The opposition of the rods compensates for changes in ambient temperature. When the probes are immersed in liquid, heat is dissipated rapidly and the temperature difference between the probes is too small for the switch to be affected. When the level falls sufficiently to expose the probes, however, heat is lost more slowly, and the temperature difference rises so that the switch is closed. The operation of the switch starts a pump to restore the level of the liquid.

A typical arrangement is shown in our drawing. The body housing the probes is of cast iron, gunmetal or aluminium, and the switch head is completely sealed from the liquid. Two models are available. One is for use with (*a*) steam boilers having a maximum working steam pressure of 120 lb per square inch, (*b*) non-corrosive fluids at 350 lb per square inch and more or less atmospheric temperature. This model is claimed to control level within about ¼in in many cases, the switch being stated to operate in eight to twelve seconds of level change. The second model (not recommended for steam plant) is offered for use at temperatures below 250 deg. Fah., and where rapid restoration of level is not needed. In this case, the switch is stated to operate in thirty-two to thirty-eight seconds of level change.

Standardised Pontoons for Floating Pierheads or Jetties

PONTOONS of standard size which can be coupled together to form floating pierheads or jetties, or used to carry piling plant or for such like duties, have been introduced by Thomas Storey (Engineers), Ltd., of Stockport. This firm also markets Bailey bridging, and the pontoon, which is known as the "Uniflote," is intended to have a similar degree of flexibility in its use as the standardised bridge units, and it is designed for use with the Bailey bridge.

The basic unit weighs about 3 tons, and has three watertight compartments. It is box-shaped, with couplings along each of the four sides, so that the pontoons can be joined together. The coupling consists of pins at top level, and hooked lugs at bottom level, thus allowing flexibility and keeping the coupling operation simple; the lower couplings can be engaged or disengaged simply by tilting one pontoon relative to the next. The pontoon is 17ft 4in long by 8ft wide by 4ft deep; centre-to-centre distances between couplings are 17ft 9in and 8ft 5in respectively. It is intended to build the pontoons in standard depths of 4ft, 6ft and 8ft. The flotation capacity is 0·32 ton per inch of draught, or about 10 tons with a freeboard of 6in.

The steel skin of the "Uniflote" pontoon is welded to its internal steel-framed structure. Each of the three compartments has a manhole and a stand pipe and coupler, which will allow ballast water to be ejected. Standardised accessories include bollards, anchors, and fenders. Protective runners on the bottom, and gunwales along the top, allow superstructures such as a Bailey bridge to be fitted.

The "Uniflote" system is to be used for a floating landing stage at Nkata Bay on Lake Nyasa. Sixteen "Uniflotes" will be connected together, and steel decking and framework for bollards and timber fendering added. A Bailey bridge will give access to the stage. A trial erection has been carried out by Thomas Storey, Ltd., at a local reservoir.

Platinum Resistance Thermometer for 1000 Deg. Cent.

WE have received some details of a platinum resistance thermometer designed for repeatable and stable performance at temperatures up to 1200 deg. Cent. It is made by C.N.S. Instruments, Ltd., 61, Holmes Road, London, N.W.5, and is suitable for use with the company's proportional temperature controllers.

The thermometer consists of a recrystallised alumina sheath which contains the temperature sensitive element of platinum, and is specified as being gastight over the operating range of temperature. The top of the sheath is secured to an asbestos composition mounting board with connections for the thermometer and compensating leads. In its standard form the sheath is 0·3in external diameter and its length is either 6in or 10in.

The elements have a cold resistance of either 5–6 ohms or 9–10 ohms and they are non-inductively wound on a former which is separately supported from the sheath. The maker states that a control accuracy of ±1 deg. Cent. at 1200 deg. Cent. is practicable, and that long-term drift from the control temperature is within the accuracy of measurement of platinum/rhodium platinum thermocouples.

Industrial and Labour Notes

The T.U.C. and Wages

Wages policy was one of the subjects debated on Thursday of last week at the eighty-ninth Trades Union Congress. A composite resolution, moved by Mr. Frank Cousins, urged that while prices and profits remained uncontrolled the unions should take such steps as would ensure that wages kept pace with rising costs. In his speech, Mr. Cousins made it plain that the resolution rejected wage restraint while prices and profits remained uncontrolled. He said also that the unions wished to affirm their belief in the principle of collective bargaining as a means for dealing with their problems. The unions, Mr. Cousins added, would be prepared to take every step through negotiation and, if proper, through reference to arbitration, but they reserved their right to withdraw their labour. The resolution was carried.

Another resolution discussed on the same day was one on the shorter working week, submitted by the Amalgamated Union of Foundry Workers. This resolution called on the T.U.C. to pledge its full support to affiliated unions in their efforts to secure a shorter working week with no loss of pay, and to establish a working day and week for all manual workers of no more than eight hours a day and forty hours a week. During the debate on the resolution, it was argued that the principle of the shorter working week was not a matter for dispute. Mr. Dalziel, of the Amalgamated Union of Foundry Workers, asserted that, where differences did arise, they were on the question of how soon that principle could be applied. So far as the engineering industries were concerned, he added, he believed that the time was now.

Investment and Wages

Observations on industrial investment and also on the subject of wages in industry were made by Sir Harry Railing in his chairman's address at the annual meeting, last week, of The General Electric Company, Ltd. Sir Harry said that the rising needs for investment in industry had been brought into prominent relief during the last decade. Increasing funds had been and would be required for three purposes : first, to provide accelerated replacement and modernisation of existing plant ; secondly, to provide the funds required for an expanding volume of turnover and, thirdly, to engage in new ventures and new fields, either because they would replace present products or because they promised new outlets.

As a nation, Sir Harry went on, Britain continued to lag behind in industrial capital investment. Some firms, particularly the leaders in industry, invested more than the national average, but on a national scale the investment programme of private industry was still inadequate. Manufacturing industry's gross investment, Sir Harry pointed out, had grown during the past four years and accounted for 27·6 per cent of the total in 1956, but it was still too low and was slightly below the 1952 figure of 28 per cent. The net addition to productive equipment, excluding housing, factory construction and obsolescence, amounted only to 2·5 per cent of the gross national product in 1956, against 2·8 per cent in 1955 and 2·9 per cent in 1952. While net investment in Germany, for instance, Sir Harry added, was running at least 50 per cent above ours, our position remained precarious.

About wages, Sir Harry commented that a high rate of production per man-year in every industry—private or nationalised, sheltered or unsheltered—was the only way to pay higher wages and to raise living standards. If they were paid on a declining or even a stagnant output, higher wages were bound to lead to a decline of the industries concerned and to losses for all who were investing their lives and their savings in them. Any attempt to reverse that process, Sir Harry emphasised, and to get higher " real " wages before the national output was raised, was bound to fail. These facts, Sir Harry continued, were clear to most responsible leaders, but the urgency for action had not yet been sufficiently grasped by the nation. Solving the problem of inflation was a national and not a partisan task. It was essential that every leader with any sense of responsibility should make it clear that real wages and incomes depended on our success in fighting further inflation. As a contribution, Sir Harry said, he welcomed the appointment of an independent council which could set out the economic facts precisely and in a clear manner.

Employment and Unemployment

The Ministry of Labour's most recent report on the employment situation in Great Britain shows that, during July, the civil labour force increased by 17,000 to a total of 23,036,000 (15,259,000 men and 7,777,000 women). Of the total, 4,001,000 were employed in the basic industries, the main increases in this group in July being seasonal ones in transport and agriculture.

In the manufacturing industries, there were 9,139,000 people employed in July. This was a net increase of 2000 over the preceding month. In the engineering, metal goods and precision instruments group, however, the number employed fell during July by 1000 to 2,773,000 people ; at the end of July last year the number of people at work in the engineering group was 2,790,000. In vehicle manufacturing, the labour force increased by 2000 during July to a total of 1,202,000 compared with 1,232,000 a year earlier. The Ministry states that, in the four weeks ended August 7, the employment exchanges filled 138,140 vacancies in all industries. The number of vacancies notified to exchanges but still unfilled on August 7 was 310,000 which was 22,000 less than a month earlier.

About unemployment, the Ministry reports that on August 12, there were 265,627 people registered as out of work, compared with 244,306 on July 15. Of the August total, 112,692 had been unemployed for more than eight weeks and 7125 were temporarily stopped. Another matter mentioned in the report is that, during the week ended July 27, there were 41,000 operatives on short time in manufacturing establishments, which was 17,000 less than a month earlier.

Oil Consumption

There was a marked recovery in the level of the United Kingdom's oil consumption in the second quarter of this year, which saw the re-opening of the Suez Canal, according to figures just published by Petroleum Information Bureau. The figures show that, over the first half of 1957, demand for all oil products totalled 11,540,885 tons, against 12,640,199 tons in January-June last year, a drop of 8·7 per cent. During the second quarter, however, deliveries were down by only 2·2 per cent, compared with 1956, as against a fall of no less than 14·7 per cent in the first quarter. Among individual products, motor spirit deliveries improved after the Budget, but the half-year's consumption, at 2,523,126 tons, was still 17·7 per cent below that for the first half of 1956.

Industrial Education

The North Gloucestershire Industrial Education Council, a body purposing to further and promote education for industry, with particular emphasis on engineering, as part of the school curriculum, is convening a conference on modern technological education for industry at the Queen's Hotel, Cheltenham, on October 9 and 10, 1957. Announcing this, Sir John Evetts, the chairman, and Sir Roy Fedden explained that the council was directing its activities principally towards the independent schools, which handled about 20 per cent of all pupils in their area. It was not proposed to influence curricula—although better mathematics teaching was mandatory—so much as to draw attention to the opportunities existing within industry and to the clamant need for recruits of " flag officer " potential. In this respect the council valued women equally with men. Emphasising the need for a vastly greater proportion of higher education to be devoted to the sciences at the expense of the arts, attention was drawn to the existence in this country of three chairs of production engineering, and to the fact that none of them were filled. The prejudice against university training in production engineering underlay the history of aircraft appearing at Farnborough in prototype form but failing to enter service.

The conference will discuss " The School Education for an Engineering Career " on the first day and " The New Diploma in Technology " on the second. Applications for tickets may be made to the Secretary, 8, Lansdown Place, Cheltenham.

Census of Production

The Board of Trade has announced some details concerning the census of production for 1958. It will be the first detailed census since 1954, and the changes which are being made should enable the forms to be more easily completed. Less information is to be asked for and full particulars will be required only from firms employing twenty-five or more people, instead of from those employing ten or more people on productive work. For 1958, full returns will be made for only about 50,000 industrial establishments, compared with about 71,000 in the 1954 census. Altogether, the Board of Trade says, a substantial measure of relief will be given to 124,000 of the 233,000 establishments covered by the 1954 census. This is true of the larger firms which will still be asked for full returns, since for 1958 they will only be asked general and not detailed questions about their purchases of material and fuel.

The census forms will include questions on working proprietors, employment, wages and salaries, materials and fuel purchased, work given out, transport payments, stocks, capital expenditure, and sales and work done. The main purpose of the census will be to provide more nearly complete information than can be obtained monthly or quarterly about items of economic importance such as production, stocks and capital expenditure.

Inquiries about the arrangements for the census will be answered by the Board of Trade (Census Office), Lime Grove, Eastcote, Middlesex.

Development of the Vienna Water Supply

Water consumption in Vienna, after a decline in the early nineteen-thirties, had been steadily increasing from 1937 onward. In 1943 it exceeded for the first time the combined supply from the two famous aqueducts commissioned respectively in 1873 and 1910. Henceforth, more and more use was made of wells sunk within Vienna itself, but even these resources will be fully exploited within five to eight years, if the demand continues to rise at a rate of 2 to 5 per cent per annum as it did during 1947-1956. Studies are in progress with a view to tapping further water-bearing strata south of Vienna and building a third aqueduct from there. Present domestic consumption fluctuates seasonally by ±14 per cent, between 240 and 320 litres per head per day. Existing reservoirs cannot now do more than deal with the daily peaks. To obtain seasonal storage capacity the municipality is completing at Neusiedl/Steinfeld a large reservoir, the capacity of which, 600,000 cubic metres, exceeds the total of all the other reservoirs.

PIPED water supplies came into existence in Vienna at the beginning of the nineteenth century. There were about a dozen of the early conduits, the best-known ones being the Albertinische Wasserleitung (1804) and the Kaiser-Ferdinands-Wasserleitung (1841). They brought the water from local wells to various distribution points, whence it was taken to the houses by water carts. The rapid growth of the population during the following decades, and the constant danger of epidemics from wells which were sited in the town and were liable to be contaminated, decided the Municipality in the 1860s to build the first aqueduct (completed 1873), together with a general distribution network. Very soon, however, the demand for water began to exceed the capacity of the new system, and the decision was taken to construct another aqueduct. Owing to various delays, the second aqueduct did not come into service until 1910. Its commissioning solved the water problem for many years, and it was not until 1943 that consumption outran the delivery available from these two aqueducts.

The springs which feed the first aqueduct lie in the region of the Rax, Schneeberg, and Schneealpe mountains, approximately 80km south-west of Vienna. Those of the second aqueduct are situated in the 25km-long Hochschwab range, some distance due west of the Rax massif, and 100km to 120km from the capital. All these mountains are of limestone or dolomite. Their tops and slopes show the typical Karst configuration, thin top soil with short vegetation alternating with more or less complete erosion. The significance of this in relation to the water supply will be mentioned later.

Both intake areas are now exploited to almost full capacity. In addition, subsidiary springs and wells, some of which date back to the 1880s, are fed into the lines at various points. Details of the two schemes may be seen from Table I.

TABLE I—*First and Second Aqueducts*

First aqueduct completed	1873
Second aqueduct completed	1910
Combined annual capacity, million cubic metres	112-118
Pipes with internal diameters up to 1100mm, km	32
Galleries, km	108
Concrete, brick, or stone conduit, km	157
Bridges, km	11
Total combined length, km	308
Number of intakes and pressure relief chambers fitted with valves	89
Protected gathering areas, total sq. km ...	482·00
Area at present in municipal hands (until 1934, 123·74 sq. km), sq. km	175·18

During the last twenty years it became necessary to utilise wells sunk within the city, including emergency supplies built at the beginning of the war. The largest are those at the waterworks on the Danube canal at Nussdorf, where eight wells yield a total of 50 to 60,000 cubic metres per day, and at Pragerstrasse and Smolagasse on the left bank of the Danube, which together produce 16,000 cubic metres per day. Surface water, to the extent of 2 to 3 per cent of the total consumption, has also been used for many decades, in the form of water impounded in the Wienerwaldsee reservoir near Unter-Tullnerbach, which feeds the Wiental aqueduct. This water is used in Vienna itself for industrial purposes only, but has to be biologically as well as mechanically filtered, as it still is the only available supply in many localities along the Wien valley.

Although unlimited quantities of Danube water are available, the use of river water is not at present considered. Purification would be extremely expensive, and the resulting product would be almost bound to be inferior in taste. Even for industrial use, the Danube is not considered suitable. About 70 per cent of the water required by industrial enterprises is derived from privately owned wells. The remaining 30 per cent is consumed for the most part by small businesses scattered throughout the Vienna area. To construct a separate second distribution grid solely for the use of these undertakings is not considered to be economically feasible.

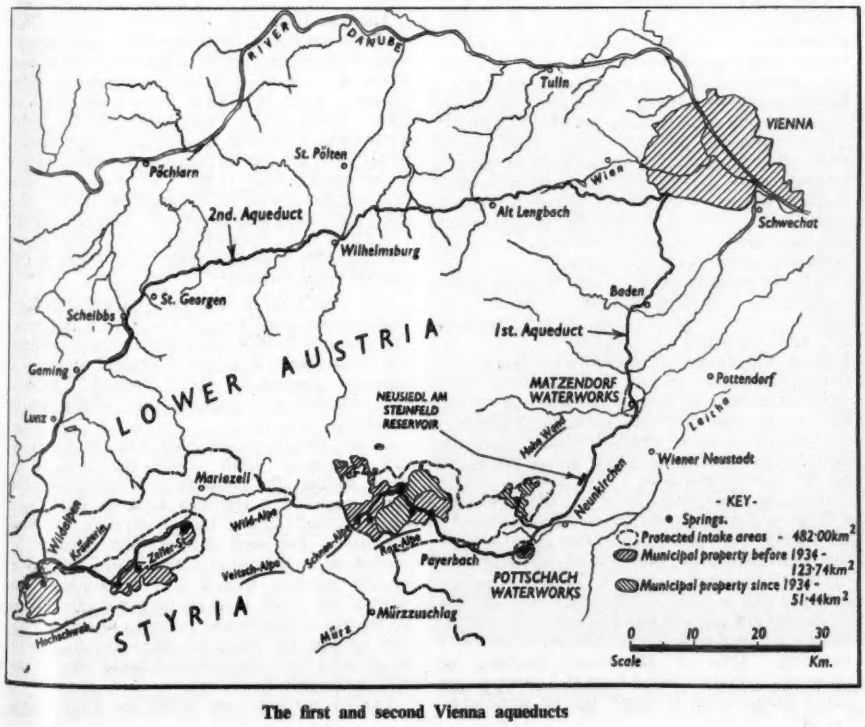
Consumption.—The increasing demands for water are, in Vienna, as elsewhere, only partly the result of population increases. For the greater part the demand was created by the supply facilities themselves which had come into existence. About 1830, the 330,000 inhabitants consumed water at the rate of about 4 litres per person per day. This consumption had by the turn of the century increased to 40 litres per head per day.

In 1956, the total amount of water from all sources amounted to 145·3 million cubic metres, of which 137·2 million cubic metres were supplied to the municipal grid, and 8,100,000 cubic metres were used by various neighbouring and associated communities, and waterworks construction sites, or had to be run off for operational reasons. Of the total grid supply, 11,000,000 cubic metres, or about 8 per cent, are estimated to have been lost through bursts and leakage, a figure which is stated to be very low compared with up to 20 per cent in other cities. About 13,600,000 cubic metres were accounted for by supplies to municipal departments (such as street cleaning, parks, and fire brigades), and errors due to low readings of obsolete water meters. The remaining 112·6 million cubic metres (82 per cent) were accounted for by meter readings. Domestic consumption in 1956 varied according to season between 240 and 320 litres per head per day, to which must be added about 200 litres per head per day for industrial consumption.

Private consumption is charged on the basis of 50 litres per day per person at 40 groschen per cubic metre, and any excess at 60 groschen per cubic metre (6d. and 9d. per 1000 gallons, respectively). These charges do not cover production costs, which are subsidised from the general budget. Other Austrian water supply undertakings are stated to "break even" with charges of 1·20 to 2 schillings per cubic metre, while German charges vary between 0·50 DM. and 1·60 DM. The administration of the water supply, it is stated, is carried out with the greatest possible economy. Thus, maintenance expenditure on the aqueducts and other objects outside Vienna amounts to approximately 2,500,000 schillings per annum, or less than 1 per cent of the book value of these installations.

Expansion.—During the ten years 1947–56, consumption rose by 2 to 5 per cent annually. The supply problem thus created is being kept under constant review by a committee which came into being in December, 1947, and on which are represented the Federal Government, the Vienna Municipality, the lower Austrian Provincial Government, and various other interested bodies, including neighbouring local supply authorities. One of the most promising potential sources which have been discovered is an area in the south of the Vienna Plain, extending north-east from Wiener Neustadt to beyond Moosbrunn, where a 2km to 4km wide and 100m deep bed of gravel is said to contain 1200 to 2300 million cubic metres of water. These reserves are not, of course, fully available. If damage to agriculture and local shortages are to be avoided, then only a proportion equal to the natural inflow can be withdrawn. Investigations which will extend over many years are in progress to determine the flow of rivers in the area, to bore test wells and to determine the effect of pumping upon the local water table.

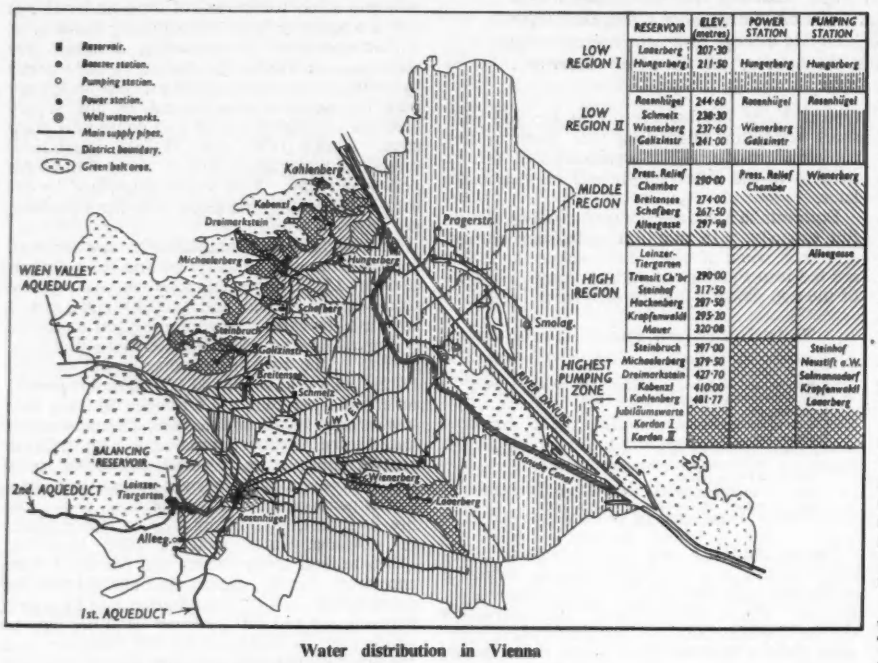
Distribution.—The municipal distribution grid



The first and second Vienna aqueducts

illustrated below has about 2300km of pipes of 50mm to 1100mm bore, including a system of trunk pipelines of over 600mm bore diameter. The pipes are of cast iron, steel or asbestos cement. About half the pipes date from before 1873, some even go back to the Kaiser Ferdinand and Albertini systems. Variations in head exceed 340m, and consequently the mains pressures range from about 2 to 13 atmospheres gauge, depending on the locality. Pipe sections are chosen so that the water velocity in the mains does not exceed 3·5m per second, or 1·5m per second in the branch pipes.

The system is fed from two neighbouring reservoirs on the south-western outskirts. Of these, the Rosenhügel reservoir (244m s.l.) is supplied by the first aqueduct, while the Lainz balancing reservoir (327m s.l.) is the terminal of the second aqueduct. Altogether, there are twenty-five reservoirs sited on the hills to the west and south-west of the town, capable of holding 530,000 cubic metres, representing one to one-and-a-half days' consumption. Because of the large differences in head, some thirteen pumping stations are in use. On the other hand, surplus energy in the water is absorbed in five hydro-electric power stations. These and other stations along the pipelines were built during the last thirty years, many only since the war, in places where the available heads made it economic to do so. Last year, a total of 46,000,000kWh was produced in this way, of which the large station near Gaming, on the second aqueduct, contributed 35,000,000kWh.



Water distribution in Vienna

A private telephone system, which, however, is not yet quite complete, links the control room with important points of the water supply, both inside Vienna and outside. A series of automatic alarms warns the controller of breakdowns.

Chlorination.—Until the end of the war, chlorination was not used in Vienna. It was first introduced in 1945 by the Allied Control Commission, and has been continued since, although the amounts of chlorine which are added have been somewhat reduced. It is considered by hygienists that a bacterial count of over 100 per cubic centimetre—not necessarily including any pathogenic organisms—signifies that the supply is dangerous. Normally, the soil is free from bacteria below depths of 6m to 8m, and sufficiently slow filtration through the deeper layers provides water of adequate quality. Owing, however, to the Karst nature of the terrain in which the main sources of the Viennese water supply are situated, filtration is inadequate. Colour tests carried out in 1955 on the Schneeberg showed that water percolates very quickly, reaching the springs within sixteen to seventy-two hours, presumably largely through fissures and clefts which provide hardly any filtering action. The danger is made worse by the large numbers of Viennese tourists which habitually visit the district. Disinfection is therefore considered to be an essential precaution.

Although the development of other methods is kept under constant review, disinfection by the addition of chlorine is still considered to be the most efficient and economical way of rendering the water safe. To do its job properly, chlorine must be added so that the excess amount is greater than 0·12 gramme per cubic metre. Such concentrations are considered to be quite harmless. Only if the water reaching the consumer contains more than 0·3 gramme per cubic metre does it begin to be noticeable.

In the case of waterworks with an output of up to 12,000 cubic metres per day, chlorine is added in the form of sodium hypochlorite solution. For the output of the two aqueducts, which yield on average 320,000 cubic metres per day, about 700 kg of hypochlorite solution would be required. It is therefore found to be more convenient to use chlorine gas, which is admixed by means of water injectors before the water enters the terminal reservoirs. The water stays in these reservoirs for ten to twenty hours, and takes several hours more to reach the consumer. The chlorine addition must be adjusted so that when the water is eventually drawn off, its free chlorine content has decayed to within the range quoted.

The Neusiedl am Steinfeld Reservoir

As was mentioned earlier on, the total capacity of the existing twenty-five Viennese reservoirs amounts to 530,000 cubic metres, i.e. only one to one-and-a-half days' consumption. It was therefore decided some years ago to increase the storage capacity by the construction of a reservoir for 600,000 cubic metres of water. The site chosen was on the first aqueduct, near Neusiedl am Steinfeld, about 60km south of Vienna, between Wiener Neustadt and Neunkirchen. The choice of this site was dictated by the desire to place the reservoir at a point where there was a steep gradient in the aqueduct, so that the water could flow to and from the reservoir through short feeder lines without any pumping. At the same time, the necessary level space for construction was available. Work was begun in 1953, and it is expected that the first of four chambers, each of which will hold 150,000 cubic metres, will come into use this year, while two more are to follow in 1958.

Building a reservoir of such a size gave rise to many interesting problems. High among the desiderata was economy. By various measures, the cost of the scheme was brought down to a figure of less than 100 million Austrian schillings (£1,400,000), or 166 schillings per cubic metre of storage space, compared with 500 to 1000 schillings per cubic metre for present-day reservoirs of smaller size.

From the point of view of construction, as well as operation, the site was very favourable. The subsoil is gravel with a load-bearing capacity of 6 kg per square centimetre. Washed and graded, part of the excavated material was used in making the concrete, thereby saving 15 per cent of the total cost. The depth of the water table was found to be 30m or more below surface, so that dewatering of the excavation was not required.

The four rectangular chambers measure 124m by 134m each, and are situated side by side with their long sides parallel. Between them is a space of 1·2m so that the structures are independent. Each is laid out for a water depth of 10m. Most of the excavated 300,000 cubic metres was deposited to form an embankment, so that the chambers extend from about 5·8m above ground level at the roof, down to 5·5m below ground level at the reservoir floor. The side wall foundations extend between about 1·6m and 3·5m below datum ; the walls themselves are 7m high and taper from 80cm at the foot to 40cm at the top.

From the bottom edge of the walls, the floor slopes down at 45 deg. to the central flat area. The concrete floor is 20cm thick and was covered over with a 6cm thick layer of special waterproof concrete, applied by the "Torkret" process and vibrated after placing, and subsequently polished.

In the design of the roof, the thickness of the customary earth cover was reduced to 40cm, so that the concrete roof could be kept down to 12cm. Previous tests at the Lainz reservoir had shown that a 40cm cover was adequate. The roof slab of each chamber is carried on reinforced concrete beams supported by 288 columns spaced at 7·5m centres. In view of the small load on each column, about 80 tonnes, it was found possible to use a very slim section, i.e. 50cm by 50cm, for a column height of 11m ; the columns could also be as illustrated opposite.

Further savings were made by constructing

(Left) No. 3 chamber under construction. The slender column design was made possible by the shallow earth cover, which will be only 40cm thick. Each column will carry 80 tonnes. For the first time, sides and roof will be of waterproof concrete, while the floor receives a 6cm thick waterproof layer. (Right) Chamber inlet, showing water injector which is to provide circulation. Note the sloping sides of the chamber

both the walls and roof of waterproof concrete, instead of applying, as is usual, a waterproofing layer. It is said to be the first time that this has been attempted, and the reliable preparation of waterproof concrete in such large quantities on a building site is considered to be a noteworthy achievement.

TABLE II—*Water Reservoir Neusiedl am Steinfeld*

Total capacity, cubic metres	600,000
Four chambers, each holding, cubic metres	150,000
Total built-up area, square metres	110,000
Depth of water, metres	10
Air space above water surface, metres ...	1·2
Roof thickness, metres...	0·12
Earth cover, metres	0·4
Number of columns per chamber	288
Size of column, metres	0·50×0·50×11·20
Load per column, tonnes	80
Floor base thickness, metres	0·20
Waterproof top layer, metres	0·06
Total floor thickness, metres	0·26
Wall height, metres	7·5
Wall thickness :	
Bottom, metres...	0·80
Top, metres	0·40

Altogether, the reservoir consumed 100,000 cubic metres of concrete, requiring 25,000 tonnes of cement and 2200 tons of reinforcement.

Pipe Layout.—From the intake chamber of the aqueduct, water reaches the reservoir through a reinforced concrete penstock of 1·6m internal diameter and 1200m length. The pipe is housed in a tunnel which merges into a 306m long distribution tunnel alongside the reservoirs. The 1200mm diameter steel pipe in the distribution tunnel in turn connects with four 600mm diameter branch pipes, which take the water to the storage chambers. In a similar manner, water from the reservoir is taken by pipes to another main in the distribution tunnel, from which it flows through a 300m long channel back to the aqueduct. The difference in level between the point where water is withdrawn and the point at which it is restored is about 15m, the gross head between the reservoir intake chamber and the reservoir distribution pipe being about 12m.

No ventilators have been provided in the roof, and the thirty-six openings provided at each reservoir for taking samples are normally kept closed. This is because the pollen from the surrounding pine forests was considered detrimental if it got carried into the water. Making a virtue of necessity, the designer avoided the intake of surface air altogether by letting the reservoir air space communicate through the pipe tunnels with the air space in the main conduit through which cold air arrives from the mountains and descends by gravity to the reservoir. Since surface air is usually warm air, its exclusion is an advantage. Moreover, the complete absence of daylight suppresses the growth of algæ.

Should the intake to the reservoir be excessive, the surplus is allowed to escape over a spillway arranged in each chamber at the 10m mark. The discharge is piped to two 4m diameter, 30m deep soaking pits, which are also used when a chamber has to be emptied for cleaning. These soak-aways are dimensioned so as to allow the whole output of the aqueduct to be drawn off, if the latter has to be emptied for repairs to be carried out.

Because of the thinness of the earth cover, special steps have to be taken to prevent the formation of layers of warmer water at the top. Two solutions are being adopted, one using a water injector at the inlet (Steinwender system, illustrated above), in the other mixing is by specially arranged guiding walls, and draw-down nozzles placed at the outlet (Geilhofer system).

Deposits of sand which settle in the reservoir have to be pressure hosed periodically into a gutter from which the sandy water flows into a sedimentation chamber. The same pump which supplies water for this purpose is used at other times for spraying the 70,000 square metres of grass cover.

The whole installation is operated from a central control room, which contains flow meters and the gear for actuating the slide valves in the inlet and outlet pipes. In the first two chambers alone 200 electric thermometers are being installed at various points, including the earth cover, roof, air and water space, and a number of positions in the floor and subsoil. Indications from these thermometers are also taken into the control room. To minimise the consequences of electric power failure, lighting and power are divided into four circuits, one of which is supplied from a battery. The instrument rooms are fully air conditioned. For routine water testing a small laboratory has also been included.

Side tunnel, connecting main distribution tunnel with one of the reservoir chambers. Left, incoming pipe, right, outgoing pipe with valve. Each pipe has an orifice plate installed

The American Scene

BY OUR AMERICAN EDITOR

Upturn in Shipbuilding

While they cannot match the current order book worth almost £1000 million of the British shipbuilding industry, American shipyards are now enjoying an order backlog of 1500 million dollars, which is eight times that of 1955. Such activity is considered to be much more than a passing flurry. Under construction or on order in U.S. yards to-day are some 101 vessels, of 2,333,872 gross tons, as compared with a mere thirty-six vessels, totalling 565,360 gross tons a year ago. This upswell in business flows mostly from two sources : the U.S. Navy's continuing programme of modernisation, and a wave of tanker orders, which began even before the closing of the Suez Canal. Beyond that, the industry has further cause for celebration. For other kinds of business either are showing new life already or promise to do so. Repair and conversion work, for one thing, has been increasing sharply, and still to be felt is the full impact of an expected replacement programme by the American shipping lines. Of some 200 firms that build and repair ships in the United States, only a few are equipped to handle the ocean-going merchant and naval vessels that carry the largest contracts. The number has been swelled lately, however, as several yards which formerly confined themselves to repair work have plunged as well into building and reconstruction. Three American firms—New York Shipbuilding, Newport News, and Bethlehem Shipbuilding —turn out ships of all kinds, large and small, naval and commercial. New York Shipbuilding, a subsidiary of the Merritt-Chapman and Scott Corporation, ranks third in the industry, and is working on several oil drilling tenders and the super-carrier " Kitty Hawk." Newport News, second biggest, has the largest and most integrated yard, which built the liner " United States " and the super-carrier " Forrestal " and now is fitting out another super-carrier, the " Ranger." Biggest of all, with eleven yards and forty-two ways, is the Bethlehem Shipbuilding Company, a division of the Bethlehem Steel Corporation.

Although it is now making a very important contribution to the bulging backlogs of the American shipbuilders, the " tanker boom " came to the American yards reluctantly, because owners can order a tanker abroad for about 60 per cent of the U.S. price. The basic reason for that discrepancy is that American yards must pay their workers roughly four times as much as those of Western Europe, and ten times as much as in Japan. To offset that disadvantage, the Government has offered construction subsidies to most American ship operators who would place orders in the United States. Two schemes of the U.S. Maritime Administration have proved moderately successful in fostering tanker construction. One of these, known as " trade-out and build," allows the tanker operator to sell an old vessel in the world market provided he agrees to build a new one, thus helping to modernise the U.S. merchant fleet. Similarly, the " trade-in and build " programme offers him an above-market price for an old ship, which then is added to the reserve fleet. Under these subsidy programmes some forty-five tankers have been ordered in American yards, which still is only a small number compared to the 169 on the books in Britain and 147 in Japan. It was only late last year, when war clouds hung over the Middle East, that new commercial orders began to arrive in quantity. Since foreign yards were booked from five to eight years ahead, the tanker operators, in a hurry for new vessels, had no choice but to build in the United States. Though new orders lately have tapered off, some shipyards now are booked as far ahead as 1961. To date, American yards have built none of the so-called giant tankers, of over 60,000 or 70,000 tons. Even before the closing of Suez the merits of such ships were being weighed because of their low operating cost per crew member. The giant tankers built in Japanese yards apparently have worked out well, and the Onassis and Niarchos interests have ordered three 106,000-ton vessels—biggest in the world—from Bethlehem. The keel of the first one of these will be laid next year. The tanker boom also has produced a " boomlet " which reaches even into the smallest yards—" jumbo-ising " : this treatment consists of cutting a tanker apart and inserting a larger mid-section, thus increasing storage space. Since the cargo-carrying part of the ship corrodes much faster than the rest, owners have been " jumbo-ising " where formerly they merely replaced the corroded sections. The new mid-section can be built and launched while the tanker is in operation elsewhere ; then, when convenient, the tanker puts into the yard to pick up its new middle, and little operating time is lost.

While the tanker operators thus have been modernising and enlarging their vessels, the U.S. Navy has embarked on an even more ambitious effort. It is making the transition to an entirely new kind of fleet, largely nuclear-powered and armed principally with guided missiles. Moreover, since combat vessels date more rapidly than their commercial counterparts, the U.S. Navy also has active conversion and replacement programmes under way. The service now has placed orders totalling 3900 million dollars for 124 new ships, 853 smaller craft, and 31 conversion jobs. This work is going on in fifty-three private and naval shipyards around the country. Furthermore, technological obsolescence, changes in configuration, and increasingly complex armaments seem to foreshadow an upward trend in naval shipbuilding. The 1958 budget provides for 1600 million dollars for this purpose, as against 1470 million dollars last year. It calls for the construction of six nuclear vessels : an 80,000-ton carrier, a cruiser, and four more submarines. Changing the method of propulsion inevitably will continue to be expensive. An increasingly atom-powered Navy, of course, by no means implies that a nuclear merchant fleet is lurking just around the corner. Last month the Atomic Energy Commission and the Maritime Administration called in the press to announce that the contract for building the nation's first fission-powered merchant ship will be awarded this autumn. The time-table calls for the keel-laying next spring and its launching a year later. The 21,000-ton vessel is scheduled to go into service by 1960. But while the craft will have tremendous capabilities, such as covering 350,000 miles without replenishing its nuclear fuel, no one expects it to be competitive economically with conventionally powered ships. At present costs, indeed, the use of atomic fuel would bankrupt any commercial operator. The advantages of nuclear propulsion lie in the compactness of the power plant and in infrequent refuelling, both merits being more applicable to combat than to merchant ships. Nevertheless, many builders feel that, if the Government's merchant ship emerges successfully from the series of rigorous tests and trials that are planned for it, a few nuclear tankers and ore carriers may be sailing the globe within ten years.

While the U.S. Navy and the oil industry thus account for most of the current shipbuilding, the industry's longer-range prosperity will depend on the continuation of the various subsidies now being paid by the U.S. Government. These, of course, do not stop with tankers. Most stem from the Merchant Marine Act of 1936, which was designed to ensure a merchant fleet adequate to support the nation's defence. Both shipping and shipbuilding, according to Washington's often-expressed view, must be kept operating, almost regardless of cost, for reasons of security. Whatever its merits, the 1936 Act unquestionably has stimulated shipbuilding. The yards are now pinning their hopes on those provisions of the law under which subsidised lines lost their favoured position if their ships were more than twenty years old. Since most of those now at sea were built between 1940 and 1945, the American merchant fleet, under these rules, faces " block obsolescence " in a few years. To avoid an undue congestion on the ways the Maritime Administration has begun negotiating with the shipping lines to space out their replacements. Involved is the ultimate construction of 172 vessels, costing some 1500 million dollars. It should be noted, however, that the Maritime Administration would be responsible for some 600 million dollars of this in " construction-differential " allowances, and that the availability of this sum depends on an unpredictable Congress. To-day serious doubts are being raised in some quarters about the future of the subsidy programme. The Secretary of Commerce recently told members of the House Merchant Marine Committee that the Administration has found no final answer in its attempts to reconcile its desire to aid shipbuilding with its objective of overall economy. The basic policy established by the Act of 1936, he said, remains unchanged. But he warned also that, " I am convinced that it is the will of the people, the intent of the Congress and the duty of the Administration to hold down spending until the growth of the economy or the lessening of defence pressures justifies some relaxation." On the other hand, at least one member of the Federal Maritime Board feels that there will be no trouble in getting Congress to appropriate the required funds when the time comes. Last month, too, the Secretary of the Navy told the House Merchant Marine Committee that the Defence Department's attitude toward U.S. shipping had not changed. and that a strong merchant marine was still " vital to the interests of the United States."

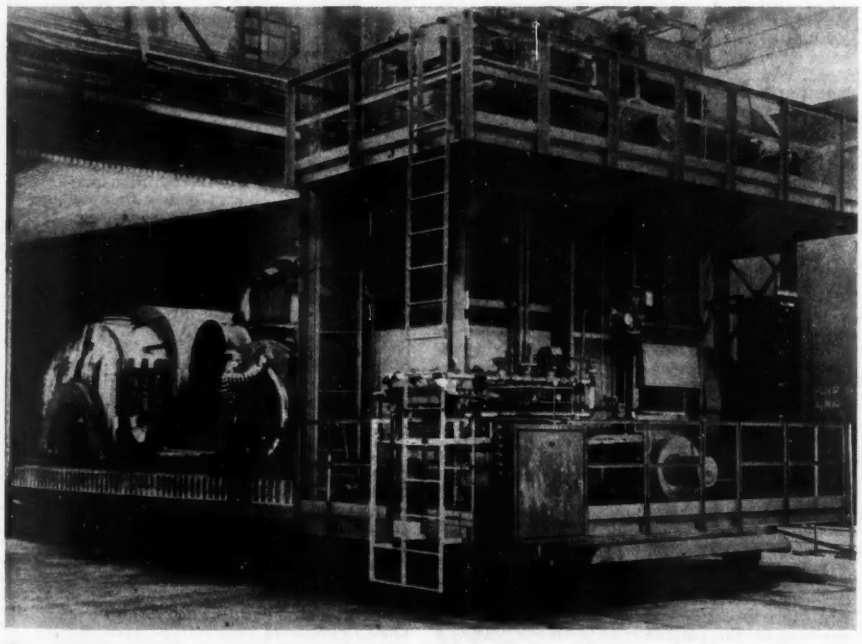
The Maritime Administration's original

schedule calls for contracts for twenty new ships to be ordered by the end of 1957. In July, the American President Lines asked for tenders to be submitted on two cargo-passenger ships for its round-the-world service, and the Moore-McCormack Lines requested bids on seven freighters for the South American service. Eventually the American President Lines will build ten ships, while Moore-McCormack will replace forty cargo vessels. The United States Lines, which also must replace thirty-seven cargo ships, is scheduled to build a sister ship to the "United States," which would replace the ageing "America." Such a vessel, however, would cost well over 100 million dollars to build, and Congress has yet to appropriate the Government's share of building costs. The pressure for continued subsidies from Washington, then, will be unrelenting in the days to come. Furthermore, in the intensifying battle between the "economisers" and the "subsidisers" the burden clearly will be on the former, in trying to call a halt to a programme that already has been under way for more than two decades. Whatever may happen to the shipbuilders' hopes for early replacement of much of to-day's merchant navy, though, the activity in American yards now and for months to come will be based firmly on the tanker programme and on the need to speed the U S. Navy's transition to a nuclear age. All in all, the recent developments in world shipping appear to have modified the "feast-or-famine" cycle that has characterised the shipbuilding industry in the past.

Large Stress-Relief Annealing Furnace

A GAS-FIRED car-bottom furnace, which is believed to be one of the largest of its kind ever built, is now being used to stress-relieve large castings at the Schenectady works of the General Electric Company. Although it carries a nominal rating of 90 tons, the large furnace has processed actual loads as high as 135 tons. The maximum load dimensions are 30ft long, 18ft wide and 16ft high. Designed and built by the company's industrial heating department, it is used for the stress-relief annealing of large castings and welded steel structures made for the Large Motor and Generator Department. The maximum furnace operating temperature is 750 deg. Cent. and the total maximum heat input to the furnace is 10,000,000 B.Th.U. per hour. Although the furnace is gas-fired, the recirculating system can operate on fuel oil.

The heating cycle is arranged for fully automatic programming. The work is heated at the rate of 50 deg. Cent. per hour, held for a specified number of hours, and cooled at the rate of 50 deg. Cent. per hour. The furnace car weighs 90 tons unloaded and is driven by a 5 h.p. motor through a fluid drive. The bulkhead door can be driven solidly up against the face of the furnace to provide an effective seal. The sand seal on the car engages a seal blade on the bottom of the furnace casing at the side and back of the furnace. Four independent systems make up the heat supply, each one consisting of a 2,500,000 B.Th.U. burner, a recirculating blower rated at 22,000 cubic feet per minute, and an individual set of controls and combustion safeguards. One instrument panel contains all four temperature control instruments, a programme controller, recorder, and other indicators. All motor starters are mounted in a motor control centre adjacent to the instrument panel.



Gas-fired, car-bottom stress-relief annealing furnace of 90 tons capacity at the Schenectady works of the General Electric Company

Atmospheric Radio Noise Recording

THE National Bureau of Standards has set up sixteen radio noise recording stations throughout the world as part of the "International Geophysical Year" programme. These stations will record the radio signals generated by more than 50,000 thunderstorms that occur daily on the earth. This noise recording programme is conducted by the N.B.S. Boulder Laboratories and is expected to increase man's knowledge of radio interference and the propagation of radio waves through the atmosphere.

The accompanying illustration shows the small building which contains one of the recording stations. The vertical rod near the centre of the building is the receiving aerial while the radiating wires are used to stabilise reception.

During the past year the atmospheric radio noise recording apparatus developed at the N.B.S. has been accepted internationally as appropriate for use in a worldwide measurement programme. These receivers provide continuous recordings of the average power of the noise received on a standard aerial at eight discrete frequencies in the range from 15 kc/s to 20 Mc/s. In addition, some sets have been modified to record also the average noise voltage and the average of the logarithm of the noise

Building containing N.B.S. radio noise recording station developed for the I.G.Y. programme

voltage. It has been shown that these three statistical characteristics of the noise provide a reasonably comprehensive picture of the physical nature of its amplitude distribution. In the course of the I.G.Y. work some man-made radio noise will also be recorded and studied. However, most of the recording sites will be as far as possible from these sources of interference. For example, one station has been installed at the Marie Byrd Base in the Antarctic, which is far removed from the radio noise of civilisation and from the belt of high thunderstorm activity circling the equator. Information will be gathered about the wireless waves that travel long distances through the atmosphere.

The Antarctic site is also an ideal place to study radio noise originating in the sun and the stars. Moreover, the station is situated within the auroral zone, and thus will provide information on the effect this zone has on wireless waves passing through it. Besides the stations in the continental United States, the stations planned for operation by the Boulder Laboratories or other U.S. agencies will include those at the Marie Byrd Base in Antarctica; at Maui, in Hawaii; at Thule, in Greenland; and at Balboa, in the Panama Canal zone. Stations which will be operated by other governments but equipped by the N.B.S. will be situated at Accra in the Gold Coast; at Cook, in Australia; at Johannesburg, in the Union of South Africa; at Rabat, in Morocco; at San Jose dos Campas, in Brazil; at Singapore, in Malaya; at Stockholm and Tokyo. India will co-operate in the network by providing and operating two stations.

All data from the various stations will be forwarded to the Boulder Laboratories for analysis. The results of this study will not only provide valuable information about radio propagation and meteorology, but will also establish an engineering basis for assigning frequencies to wireless stations. For the commercial and military radio users who must know which frequencies are best for use at a given time and place, forecasts will be made of the amount of unwanted noise that will interfere with their communications. With other information provided by the Bureau they will be able to tell the minimum transmitter power that can be used to get their information to the receiver in spite of competition from noise of natural origin.

Personal and Business

Appointments

PRIOR STOKERS, Ltd., has announced the appointment of Mr. R. Mantle as its technical representative for Birmingham and the neighbouring counties.

MR. DUDLEY SAWARD has been appointed managing director of Texas Instruments, Ltd., the British subsidiary of Texas Instruments Incorporated, Dallas, Texas.

A. REYROLLE AND CO., Ltd., has announced the appointment of Mr. W. B. Fenwick, M.I.E.E., as general works manager in succession to the late Mr. T. McCulloch.

DR. L. G. GROVES has been appointed managing director of Davy British Oxygen, Ltd., and has relinquished his appointment on the board of British Oxygen Wimpey, Ltd.

MR. HAROLD T. JOHNSON has been appointed manager, manufacturing staff, General Motors Overseas Operations, Detroit, in succession to Mr. Stanley Menton, who is to retire at the end of September.

CANADIAN PACIFIC RAILWAYS announces that Mr. J. N. Fraine has been appointed vice-president of the Pacific region, and that Mr. J. G. Strother has been appointed to succeed him as general manager of the eastern region.

LIEUT.-COLONEL K. E. BOOME has been appointed chief executive of the London office of the International Road Federation, Ltd., in succession to Sir Donald St. Clair Gainer, who has retired. Mr. W. G. Kennedy has been appointed deputy chief executive and will continue as secretary and treasurer.

GENERAL REFRACTORIES, Ltd., has announced the following appointments :—Mr. Eric C. S. Greaves has been appointed home sales manager and has been succeeded as north western area manager by Mr. E. C. Brampton. Mr. John G. Watson has been appointed north eastern area sales manager in succession to Mr. G. G. Abraham, who has been appointed technical service manager at head office.

Business Announcements

GIRLING, Ltd., states that it has transferred its entire business in power-assisted steering to Hydrosteer, Ltd., Luton.

TEXAS INSTRUMENTS INCORPORATED states that the opening of its British subsidiary plant, Texas Instruments, Ltd., Dallas Road, Bedford, will take place on October 1.

THE BRITISH STRADDLE CARRIER COMPANY, Ltd., states that its London office has moved to Fison House, 95, Wigmore Street, London, W.1 (telephone, Welbeck 5500).

INDUSTRIAL WASTE ELIMINATORS, Ltd., states that its business will in future be carried on under the style and title of Iwel Engineering, Ltd., 7–11, Old Bailey, London, E.C.4.

LANGLEY ALLOYS, Ltd., Langley, Slough, Bucks, has announced that it has concluded an agreement with Davis and Timmins, Ltd., for the manufacture and distribution of its welding electrodes and seam welding wheels in "Hidurel 6" chromium-copper alloy.

THERMOTANK, Ltd., has announced details of a working arrangement with Woods of Colchester, Ltd., under which it will discontinue the manufacture of certain classes of its "Torpedo" axial flow fans. These classes will be replaced by axial-flow fans manufactured by Woods of Colchester, Ltd., and will be known as "Thermotank/Woods" fans, and will be distributed in the marine field by Thermotank, Ltd.

Contracts

RICHARD COSTAIN, Ltd., has been awarded a contract for constructing the new Indian Ocean air base on the Maldive Islands, which is intended to replace the existing base in Ceylon. Work is to start immediately on this £2,000,000 project and will last for about two years. The plant and machinery to be used, as well as the hutting and main materials, will be obtained from this country. Aggregate for concrete will be quarried locally. Supervisory staff will be British. The tender for the project was by invitation and the work is to be carried out for the Air Ministry as part of the new strategic defence programme for the Far East.

THE CENTRAL ELECTRICITY AUTHORITY has placed contracts during the past month for power stations, transmission lines and transforming stations, totalling £15,348,440. The principal contracts include : Staythorpe B power station, three 120MW reheat boilers (John Brown Land Boilers, Ltd.) ; h.p. pipework and valves (Babcock and Wilcox, Ltd.) ; coal handling plant (A. J. Jenkins and Co., Ltd.) ; West Thurrock power station, two 200MW reheat boilers (Babcock and Wilcox, Ltd.), one 200MW turbo-generator condensing and feed heating plant (C. A. Parsons and Co., Ltd.) ; High Marnham power station, main building superstructure (Sir Alfred McAlpine and Sons, Ltd.) ; Padiham B power station, near Burnley, one 120MW reheat boiler (Simon-Carves, Ltd.) and one 120MW reheat boiler (Babcock and Wilcox, Ltd.) ; West Thurrock substation, 275kV switchgear (A. Reyrolle and Co., Ltd.) ; Uskmouth power station, Pyle, 275kV overhead line (J. L. Eve Construction Company, Ltd.) ; Staythorpe substation, two 120MVA 275/132kV auto transformers (British Thomson-Houston Company, Ltd.).

Miscellanea

PRODUCTION TURBO-SET.—The Bristol Olympus B.OI.6, newly designated the Mk.200, is now in full production for use in Avro "Vulcan" Mk. 2 bombers. The static thrust of 16,000 lb is claimed to be higher than that of any other production engine.

PETROLEUM INFORMATION BUREAU, 29, New Bond Street, London, W.1, announces that the 1957 edition of the P.I.B. Wall Map, indicating the world's oil producing and refining countries, with relevant statistics for 1956, is now available, price 2s.

ROAD ACCIDENTS IN 1956.—Casualties on the roads of Great Britain in 1956—more than 5000 killed, 62,000 seriously injured and 200,000 slightly injured—showed no significant change compared with 1955. Fewer people were killed but more were injured than in the previous year. Details of the casualties are given by the Ministry of Transport and Civil Aviation and the Scottish Home Department in the annual booklet, "Road Accidents, 1956," published by H.M. Stationery Office. It is estimated that, despite a wet summer and two months of fuel restrictions in November and December, traffic over the year as a whole rose by 3 per cent.

PILOT POWER STATION FOR UNDERGROUND GASIFICATION PROJECT.—The Central Electricity Authority has received the consent of the Minister of Power for the construction of a pilot power station at Newman Spinney, Derbyshire, to be operated in conjunction with the underground gasification project of the National Coal Board. The station will be temporary and will contain one 3750kW turbo-generator and associated boiler, and there will be one induced draught cooling tower having a capacity of 250,000 gallons of water an hour. Conditions attached to the consent are that all buildings, plant and equipment shall be removed and the site restored to its present state by December 31, 1967, and the Local Planning Authority shall have a chance to comment on final details of the proposals before works are started.

PARAFFIN MIST COLLECTOR.—A new device for the collection of paraffin mist arising from the high-pressure spraying of paraffin in cleaning booths is being made by B.S. Developments, 14, Marlborough Road, Woking, Surrey. With this equipment mist-laden air is drawn into a grille-protected chamber, where it enters the scroll inlet of a static turbo-separator. The high radial velocities obtaining within the separator cause the globules to gyrate round the walls and fall to the tank as liquid, the cleaned air passing upwards through the central core to the fan and discharge stack. A number of spray cabinets can be connected together with ductwork and a central plant with multiple separators arranged either to return the liquid to the central storage, or to built-in tanks. Where space is limited the collector can be mounted on the roof of a cabinet.

TRAINING PUBLIC HEALTH INSPECTORS.—The recently formed Public Health Inspectors Education Board has issued details of its new diploma scheme, which envisages a four years' course of training, under a system of paid pupillage with local authorities. The work of the scheme will be administered on behalf of the board by the Royal Society of Health. Entrants to the scheme, states the board, must have general certificates of education in four approved subjects at ordinary level, or certain other approved qualifications. Training will be on the basis of part-time day release, or an equivalent arrangement such as a sandwich course, with an examination at the end of each year of training. The position of students already in training will be safeguarded. Colleges providing theoretical instruction must have local facilities for practical training which will be on a whole-time basis, and the local authorities to be approved for this purpose must be able to provide a sufficiently comprehensive field of practical work for students. Local authorities will be invited, in due course, to apply to the board for such recognition, and a list of those approved will be published. There would be a sufficient number of courses, states the board, to provide the public health inspectors required and 1958–59 is to be the first session of the new training scheme. The final examination will consist of written papers, a practical examination and an oral examination, and successful candidates will be awarded a diploma.

ENGINEERING SAFETY CODES.—During the period 1933–1935, Imperial Chemical Industries prepared a series of engineering safety standards for use within its own organisation. They served a valuable purpose and were of material assistance in reducing the accident frequency rate to less than one-half of its former level within the company. This has encouraged the company to revise and extend these safety manuals under the title of "I.C.I. Engineering Codes and Regulations (Safety)," which have been made available to industry through the Royal Society for the Prevention of Accidents. The latest edition to appear is the first of a series dealing with safety in relation to electrical engineering, and the use of electricity with safety in a chemical works. Although it is not to be taken as an official publication, it is considered that the booklet covers all rules and regulations likely to be encountered in this type of work.

EXPERIMENTAL STEAM ENGINE.—A steam engine for experimental work in college and university laboratories which is made by W. Simon and Co., Ltd., Simon Road, Gloucester, can be arranged for single or compound operation or, if required, a low-pressure engine can be added, when required, to an initially installed single expansion engine. The two engines are mounted on a common bedplate and have cylinders of 6in and 8¼in bore by 4in stroke. The normal steam pressure of 100/120 lb per square inch can be increased up to 200 lb per square inch maximum and the high-pressure cylinder bore reduced for high-pressure working. When arranged for single expansion, the rating of the engine is 8, 10 and 12 b.h.p. at 200, 250 and 300 r.p.m. respectively. With a compound set the respective ratings at the same speeds are 10, 13 and 15 b.h.p. Indicator gear is fitted on both engines. A Meyer variable expansion valve gear on the h.p. engine can be fitted to the l.p. engine as an extra; it gives a variation in cut-off from 0·2 to 0·8 stroke.

ECONOMIC TRENDS IN THE USE OF ENERGY.—A sectional meeting of the World Power Conference is to be held in Canada next year, from September 7 to 11 in Montreal. The theme of the conference is to be "economic trends in the production, transportation and utilisation of fuel and energy." The Canadian national committee points out that by placing emphasis on economic aspects of problems related to energy resources, the sectional meeting will seek to explore in particular the economic implications of recent technical advances in the production and use of energy. It is evident, for example, that the advancement of nuclear studies at the present rapid rate will profoundly affect economic relationships of other sources of energy. It is possible that this is turn may change the entire economic climate of an area. The sectional meeting, within the limitations imposed by this emphasis on economics, will treat the basic theme in three main subdivisions dealing with : (i) production, (ii) transportation, and (iii) utilisation. The three main subdivisions of the theme are further divided into sections suggested by the natural classification of subject matter : production, for the most part by physical state of fuels ; transportation by media ; and utilisation by type of consumer.

THE LATE MR. J. C. MARTIN.—The death of Mr. John Charles Martin, late deputy chief engineer to the Manchester Ship Canal Company, occurred on August 30, 1957, at the age of seventy-two years. Mr. Martin retired after fifty-seven years' service with the Manchester Ship Canal Company, in September, 1954. He joined the company at the age of thirteen as a junior in the chief engineer's department and spent the whole of his engineering career with them. He was transferred to the outside engineering staff in 1913 and has held the position of resident engineer on both the tidal and non-tidal divisions of the canal. He was responsible for carrying out many major development works, including the construction of Stanlow oil docks and the Eastham crane berth. Mr. Martin was appointed deputy chief engineer in September, 1945, and continued in that position until September, 1949, when he retired from the permanent staff of the company. He was, however, appointed constructional engineer as from October, 1949, for the projected Queen Elizabeth II Dock at Eastham, and thus, at the end of his career, he was able to exercise an important influence on this large-scale project. He retired from this position on completion of the work in September, 1954. Mr. Martin was a Member of the Institution of Civil Engineers.

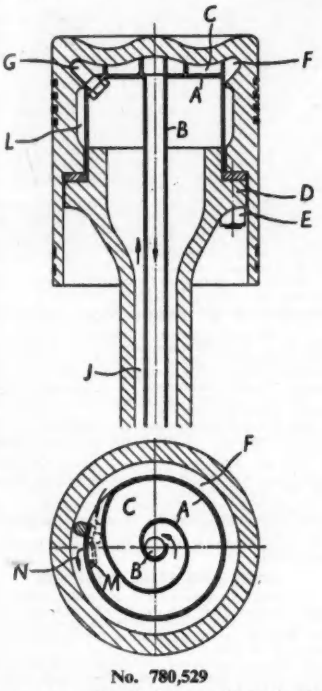
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgement is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

INTERNAL COMBUSTION ENGINES

780,529. May 9, 1955.—THE COOLING OF PISTONS, Sulzer Freres, Societe Anonyme, of Winterthur, Switzerland.

According to the invention, a liquid cooled piston for an internal combustion engine includes an insertion which can be fitted as a unit into the interior of the piston. With the piston body it forms an annular space adjacent the rim of the crown, and inlet and outlet openings for the cooling medium, a separate detachable partition element in the annular space lying between the inlet and outlet openings



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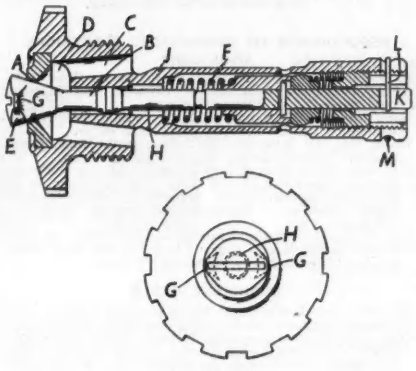
being provided. It will be seen from the drawing that an insertion *A* is pushed into a bore in the piston, and a central pipe *B* is connected to it. In addition a spiral path *C* is formed between the upper surface of the insertion and the piston crown. The insertion *A*, together with the hollow piston rod *D*, is secured to the piston by a number of screws *E*. A concentric annular space *F* formed by a recess in the region of the rim of the piston crown is closed on the inside by the insertion. A partition element in the form of a bolt *G* extends into the annular space. The cooling medium, such as oil, is supplied through the duct *J* between the piston rod and the pipe and follows the arrowed path through an aperture in the insertion wall into an annular space *L* between the piston and the insertion. From there the cooling medium can only enter the space *F* through a bulge or recess *M* in the wall of the insertion adjacent the bolt *G*, as is shown by the arrow *N*. The cooling medium then flows around the periphery of the annular space until it is prevented by the partition bolt from flowing further and is deflected into the spiral path *C*. The cooling medium is finally discharged through the pipe *B*. Other partition elements than the bolt *G* can be used.—*August* 7, 1957.

780,744. July 6, 1954.—PRIME MOVERS, Bristol Aero-Engines, Ltd., Stonebridge House, Colston Avenue, Bristol. (*Inventors: Kenneth Stanley Powell and Michael Roy Williams.*)

The invention relates to ram-jet engines and its object is to improve the distribution of the fuel without necessitating an increase in the number of spraying devices. Referring to the drawing, the spraying device may be of the kind having a variable area jet orifice *A*, controlled as to area by a spring-loaded pintle valve, generally indicated at *B*, the valve having a conical head and being opened to increase the area of the orifice by the pressure of fuel delivered through ducts *C* to a chamber *D* behind the head of the valve. According to the invention, the forward part *E* of the head of the valve *B* is of an elliptical or other flattened truncated conical form so that the particles of fuel leaving the orifice are deflected to a greater angular divergence in a plane containing the major axis of the cross section of the forward part *E* of the head than in a plane at right angles to it. In the example being described the orifice *A* is circular and the rear part of the head of the valve *B* is of conical shape so as to be able to close the orifice



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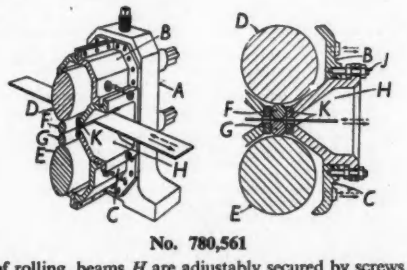
when the pressure of fuel delivered to the chamber *D* is insufficient to overcome the spring *F* urging the valve to close the orifice. The forward part of the head is formed with a pair of lateral projections or ears *G* to give a flattened truncated conical form as described above. Alternatively, however, the forward part could be made of elliptical truncated conical shape, or, again, the orifice *A* could be of elliptical or other flattened shape, in which case the whole of the head of the pintle valve would be in the form of an elliptical or other flattened cone, having cross sections in planes parallel to the plane of the orifice of a shape similar to the shape of the orifice. Spraying devices as described are each arranged in the annular air passage of a ram-jet engine with the major axis of the cross section of the forward part *E* of the head of its pintle valve extending tangentially of the passage. In order that the forward part *E* may be maintained with its cross section correctly orientated in the passage, the spindle *H* of the pintle valve *B* is extended throughout a body *J* and is slotted as at *K* at its rear end. The slot receives a projecting part *L* of a circular spring clip *M* passing through the body. If desired, a spraying device may include an air deflector described in the specification.—*August* 7, 1957.

METALLURGY

780,561. November 15, 1955.—FOUR-ROLL ROLLING MILL, Gesellschaft der Ludw. von Rollschen Eisenwerke AG., Gerlafingen, Switzerland.

The object of the invention is a four-roll rolling mill in which the support for the working rolls is so designed that it can absorb maximum stresses. As shown in the drawing, the columns *A* of the rolling mill are interconnected by housings *B* and *C* which enclose the backing rolls *D* and *E*. For the purpose of supporting the working rolls *F* and *G* in the direction



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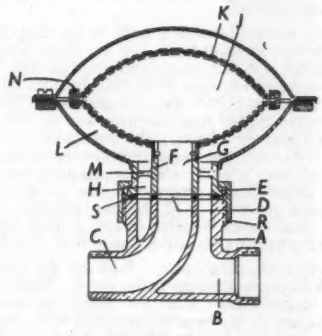
of rolling, beams *H* are adjustably secured by screws *J* to the housing *B* and *C* parallel to the direction of rolling. The beams form together a funnel-shaped cross-section. Compression springs, cams, keys or pistons actuated by a pressure medium, &c., may be provided for beam adjustment. The beams *H* have insert rails *K* to support the working rolls *F* and *G* and they consist of a bearing material to prevent the rolls from being pitted by the rails. In order to cool or, if necessary, heat the working rolls or the backing rolls, a suitable medium can be passed through the spaces between the housings and rolls. Owing to the two columns being interconnected by the housings the rigidity of the entire rolling mill is substantially increased. The housings, which serve as a bearing for the supporting beams and are secured to the columns, provide a high degree of stability in the direction of rolling and permit the use of horizontally displaceable, funnel-shaped supporting beams to enable the material being rolled to be inspected without obstruction.—*August* 7, 1957.

GAS FILTRATION

780,504. December 10, 1954.—GAS FILTER CONNECTIONS, G. Kromschroder Aktiengesellschaft, 6, Jahnplats, Osnabrück, Germany.

The object of the invention is to provide a structurally improved gas filter. According to the invention, the filter housing has a double connecting socket comprising two sockets arranged one within the other concentrically and forming two concentric channels, the filter body being detachably connected to the inner socket, preferably by means of a bayonet joint. As shown in the drawing, a pipe adapter *A* is built into a gas pipe as a fixed component.



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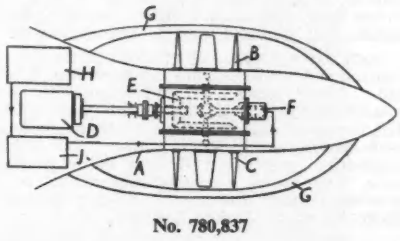
The pipe adapter has two channels *B* and *C*, which are separate from each other and open concentrically into a common sealing face *D*. The housing of the gas filter has a corresponding double connecting socket *E* and *F*, which forms two channels *G* and *H*, the inner channel *G* of which communicates with the inner space *J* of a filter body *K*. The outer channel *H* opens into the space of the housing outside the filter body. The filter body *K* is pushed on the inner socket *F* and fixed by a bayonet joint. A sealing ring seals simultaneously the inner and outer channels of the connection and it is immaterial whether the unfiltered gas enters through the channel *B* or *C*.—*August* 7, 1957.

MARINE ENGINEERING

780,837. February 23, 1955.—PROPULSION SYSTEM FOR SHIPS, Research Interests, Ltd., formerly Pollopas Patents, Ltd., 79, Davies Street, Oxford Street, London, W.1. (*Communicated from Carl Von Den Steinen, 2, Gruener Redder, Hamburg-Bergedorf, Germany, and Louis Eugene Widolt Montrose-Oster, 152, Chaussee de la Hulpe, Bruxelles-Boitsfort, Belgium.*)

It is known that advantages can be achieved in ship propulsion, if the propelling means are located at the bow of the ship. There is the disadvantage, however, that due to pitching, the bow of the vessel



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often moves completely out of the water, which not only produces inefficiency, but also is liable to produce undue strain on the ship's motor. The drawing shows a plan view of the bow of a ship equipped with two blade-wheel propellers in accordance with this invention. It will be seen that the bow of the ship is formed with a narrow forward extending portion *A* from opposite sides of which project the blades of two propellers *B* and *C*. The propellers are rotated at a nearly constant speed by a common driving motor *D* through gearing *E*. *F* is a servo-motor controlling the inclination of the blades for determining the direction or directions of the thrust. The blades may be protected from damage by guards *G*. This ship is provided with a pitching detecting device *H*, the output of which is fed into a control *J* which automatically controls the operation of the servo-motor *F* so that the blades produce also a thrust to counteract pitching. The control *J* is also actuated manually to control the operation of the servo-motor *F* for driving the ship ahead or astern. The automatic part of the control produced by the anti-pitching detector is combined with that part produced manually.—*August* 7, 1957.

Launches and Trial Trips

SAN GREGORIO, oil tanker ; built at Barrow by Vickers-Armstrongs, Ltd., for the Eagle Oil and Shipping Company, Ltd.; length between perpendiculars 635ft, breadth moulded 84ft 3in, depth moulded 46ft 3in, draught, summer, 34ft, deadweight 31,000 tons, speed 16½ knots ; one high-pressure and one mixed-pressure, 550kW, 450V, 60 c/s, geared turbine alternators, one 200kW diesel-driven emergency generator ; one set of double reduction geared turbines, 13,000 service s.h.p. at 105 propeller r.p.m., 14,500 maximum s.h.p. at 109 propeller r.p.m., two Babcock and Wilcox integral furnace boilers supply steam at 600 lb per square inch and 850 deg. Fah. Launch, July 26.

TIDEWATER, oil tanker ; built by the Chantiers de l'Atlantique Penhöet-Loire for the Tide Water Oil Associated, U.S.A.; length overall 785ft 7½in, length between perpendiculars 747ft 11in, breadth moulded 102ft 2½in, depth 51ft 8in, draught loaded 38ft 6in, deadweight 51,850 tons, displacement 67,100 tons ; service speed 16·5 knots ; thirty-six oil cargo tanks, four 1140 tons per hour turbine-driven cargo oil pumps ; two 650kW, 450V, turbo-generators, one 75kW diesel-driven generator ; one set of double-reduction geared C.E.M.-Parsons turbines, 19,000 s.h.p., two Foster-Wheeler boilers supply steam at 600 lb per square inch and 850 deg. Fah. Trial, July.

LOUIS L.D., cargo ship ; built by the Chantiers de l'Atlantique Penhöet-Loire for L. Dreyfus and Co.; length overall 442ft 9in, length between perpendiculars 427ft, breadth moulded 61ft, depth to shelter deck 40ft 6in, draught 27ft, deadweight 11,000 tons, speed 14 knots ; three 180kW generators ; Sulzer Mark 7SD72 diesel engine, 4900 h.p. Trial, July.

ARICA, cargo ship ; built by the Forges et Chantiers de la Mediterraneé (La Seyne) for Skibs Viator, Norway ; length overall 489ft 2in, length between perpendiculars 459ft 4in, breadth moulded 62ft 5in, depth 39ft 5in, draught 27ft 11in, deadweight 13,000 tons, four holds ; three 200kW diesel-driven generators ; La Seyne-Sulzer Mark 8SD72 diesel engine, 5600 h.p. Trial, July.

BRITISH JUSTICE, oil tanker ; built by Cammell Laird and Co. (Shipbuilders and Engineers), Ltd., for the B.P. Tanker Company, Ltd.; length between perpendiculars 630ft, breadth moulded 85ft 6in, depth moulded 46ft 8in, summer draught 35ft, deadweight 32,000 tons ; thirty cargo oil compartments, one main pump room ; two 600kW turbo-alternators, one 150kW diesel-driven alternator, one 75kW steam-driven alternator ; one set of compound, double reduction geared turbines, 15,500 maximum s.h.p., steam supplied at 600 lb per square inch and 850 deg. Fah. by two Babcock and Wilcox boilers. Launch, July 26.

KOONYA, cargo ship ; built by Henry Robb, Ltd., for the Union Steam Ship Company of New Zealand, Ltd.; length between perpendiculars 235ft, breadth moulded 45ft, depth moulded to upper deck 16ft, deadweight 1950 tons on 14ft 7in mean draught, designed trial speed 11 knots ; two holds, 90,000 cubic feet capacity, eight 5-ton derricks, electric winches, three 114kW diesel-driven generators ; British Polar M58M eight-cylinder, two-stroke, diesel engine, 1280 b.h.p. at 250 r.p.m. Launch, July 30.

LOCH LOYAL, cargo liner ; built at Belfast by Harland and Wolff, Ltd., for the Royal Mail Lines, Ltd.; length between perpendiculars 470ft 8½in, breadth moulded 68ft, depth moulded to shelter deck 41ft, five cargo holds, one 30-ton, six 10-ton, fourteen 5-ton derricks, twenty electric winches ; four 300kW diesel-driven generators ; Harland and Wolff two-cycle, single-acting, opposed-piston engine, seven cylinders, 750mm diameter by 2000mm combined stroke, 110 r.p.m. Launch, August 9.

Catalogues and Brochures

BLICK TIME RECORDERS, Ltd., 96–100, Aldersgate Street, London, E.C.1.—Folder giving details of a master control system for visual, audible and recorded time.

BROCKHOUSE ORGANISATION, 25, Hanover Square, London, W.1.—Booklet giving details of subsidiary companies and branches of the Brockhouse Organisation, and of the products manufactured.

KODAK, Ltd., Kodak House, Kingsway, London, W.C.2.—Catalogue of light filters for commercial, industrial, portrait, clinical, scientific, technical and general photography, in black and white and in colour.

HOWARD CLAYTON-WRIGHT, Ltd., Wellesbourne, Warwickshire.—Technical brochure describing some applications of "Clayflex" flexible bearings. Detailed lists of standard and miscellaneous sizes are included.

LA MONT INTERNATIONAL ASSOCIATION, Ltd., 42, Leicester Square, London, W.C.2.—Booklet entitled "The La Mont Boiler," illustrating and describing the system of forced and controlled recirculation and its application in various fields of steam generation.

STURTEVANT ENGINEERING COMPANY, Ltd., Southern House, Cannon Street, London, E.C.4.—Publication No. 7009, entitled "Electrostatic Precipitation," giving technical details of the design and construction of some of the units manufactured and describing some typical installations.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Tues., Sept. 17.—YORK BRANCH : Royal Station Hotel, York, "Earth Leakage Protection of Domestic and Industrial Installations," J. A. Robbins, 7.30 p.m.
Wed., Sept. 18.—S.W. LONDON BRANCH : Visit to the Associated Rediffusion Television Studios, Wembley, 2.30 p.m.
Thurs., Sept. 19.—KENT BRANCH : Shakespeare Hotel, Sittingbourne, "Electrical Safety," S. J. Emerson, 7.30 p.m.
Fri., Sept. 20.—LIVERPOOL AND DISTRICTS BRANCH : Evening visit to John Summers and Sons, Ltd., Hawarden Bridge Steelworks, Shotton, Chester. ★ STOKE AND CREWE BRANCH : Royal Hotel, Crewe, "Science and Responsibility," M. Pittock, 7.30 p.m.
Sat., Sept. 21.—OXFORD, READING AND DISTRICTS BRANCH : Collier Lecture Room, Regent's Park College, Pusey Street, Oxford, "Electric Railway Signalling," 7 p.m.

ENGINEERS' GUILD

Fri., Sept. 20.—S. WALES AND MONMOUTHSHIRE BRANCH : Old Arcade Inn, Church Street, Cardiff, Luncheon, 12.45 p.m.
Thurs., Sept. 26.—METROPOLITAN BRANCH : Caxton Hall, Caxton Street, Westminster, London, S.W.1, Annual General Meeting, Discussion on "The Aims and Future Policy of the Guild," 6 p.m.

INCORPORATED PLANT ENGINEERS

Tues., Sept. 17.—BIRMINGHAM BRANCH : Hotel Leofric, Coventry, "Titanium as a Material of Construction in the Chemical Industry," K. W. J. Bowen, 7.30 p.m.
Wed., Sept. 18.—KENT BRANCH : King's Head Hotel, High Street, Rochester, Ladies' Film Evening, 7 p.m.
Thurs., Sept. 19.—BLACKBURN BRANCH : Golden Lion Hotel, Blackburn, Joint Meeting with Institute of Fuel, "Fuel and Power Position in the United Kingdom," Rear-Admiral Sir Sidney Frew, 7.30 p.m.
Tues., Sept. 24.—GLASGOW BRANCH : Scottish Building Centre, 425–427, Sauchiehall Street, Glasgow, Joint Meeting with the Institution of Heating and Ventilating Engineers, "Steam," and "Combustion and the Chain Grate Stoker," 7.15 p.m. ★ S. WALES BRANCH : South Wales Engineers' Institute, Park Place, Cardiff, "Metal Degreasing by Trichloroethylene," and "Metal Pretreatment in Industry," 7.15 p.m.
Thurs., Sept. 26.—SHEFFIELD AND DISTRICT BRANCH : Grand Hotel, Sheffield, "The Design of Rolling Mills, with particular reference to Hot and Cold Ferrous Mills," M. Langen, 7.30 p.m.
Fri., Sept. 27.—BIRMINGHAM BRANCH : Imperial Hotel, Temple Street, Birmingham, "Some Principles of Radiant Heating," P. A. Coles, 7.30 p.m.
Mon., Sept. 30.—W. AND E. YORKSHIRE BRANCH : Leeds University, "The Safe Use of Electricity," J. J. Emerson, 7.30 p.m.
Tues., Oct 1.—GENERAL MEETING : Royal Society of Arts, John Adam Street, Adelphi, Strand, London, W.C.2, "Reactor Plant Engineering," R. F. Jackson, 7 p.m. ★ E. MIDLANDS BRANCH : County Hotel, Theatre Square, Nottingham, "The Heat Pump : Some Aspects of its Application," J. A. Sumner, 7 p.m. ★ EDINBURGH BRANCH : 25, Charlotte Square, Edinburgh, "Practical Plant Engineering in the Chemical Industry," C. W. Winstock, 7 p.m. ★ PETERBOROUGH BRANCH : White Lion Hotel, Church Street, Peterborough, "Hydro-Electric Power Development," G. C. Cummings, 7.30 p.m.
Wed., Oct. 2.—LEICESTER BRANCH : Bell Hotel, Leicester, "Factory Flooring," F. C. Harper, 7 p.m. ★ SOUTHERN BRANCH : Royal Beach Hotel, Portsmouth, "The Engineer and the Clean Air Act," E. C. Rogers, 7.30 p.m.
Tues., Oct. 8.—MANCHESTER BRANCH : Engineers' Club, Albert Square, Manchester, "Chain Grate Stokers," C. H. G. Hayward, 7.15 p.m.
Thurs., Oct. 10.—GLASGOW BRANCH : Scottish Building Centre, 425–427, Sauchiehall Street, Glasgow, "The Measurement and Prevention of Smoke from Industrial Boilers," T. F. Hurley, 7.15 p.m. ★ MANCHESTER BRANCH AND MERSEYSIDE AND N. WALES BRANCH : Joint Meeting, Aboard Clubship "Landfall," "What Purpose does Incorporated Plant Engineers Serve ?" 7.15 p.m. ★ N.E. BRANCH : Roadway House, Oxford Street, Newcastle upon Tyne, "The Manufacture of Tubes," H. B. Elliot, 7 p.m.
Mon., Oct. 14.—DUNDEE BRANCH : Mathers Hotel, Dundee, "Boiler Feed Systems and Auxiliaries," J. R. Cairns, 7.30 p.m.
Wed., Oct. 16.—KENT BRANCH : Kings Head Hotel, High Street, Rochester, "The Generation of Power from Atomic Energy," H. R. M. Hyder, 7 p.m.
Thurs., Oct. 17.—BLACKBURN BRANCH : Golden Lion Hotel, Blackburn, "Man Management," A. Roberts, 7.30 p.m.
Fri., Oct. 18.—BIRMINGHAM BRANCH : Imperial Hotel, Lower Temple Street, Birmingham, Mobile Plant Discussion Group, "Planned Maintenance on Equipment on Building Sites," Walter T. Scopes, 7.30 p.m.
Tues., Oct. 22.—S. WALES BRANCH : South Wales Engineers' Institute, Park Place, Cardiff, Films on "Methods of Mechanical Application," "Reclamation of Oil," and "Conservation of Grade," 7.15 p.m.
Thurs., Oct. 24.—LONDON BRANCH : College of Preceptors, Bloomsbury Square, London, W.C.1, "Complexity of Plant and the Training of Operatives," N. D. Pirrie, 7 p.m.
Mon., Oct. 28.—WEST AND EAST YORKSHIRE BRANCH : Leeds University, "Thermoplastics, with particular reference to their Application in Tube Manufacture and Usage," J. Aldred, 7.30 p.m.
Thurs., Oct. 31.—SHEFFIELD AND DISTRICT BRANCH : Grand Hotel, Sheffield, "The Radar Telescope," H. C. Husband, 7.30 p.m.

INSTITUTE OF FUEL

Wed., Oct. 9.—Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1, Symposium on "Flames and Industry," 10 a.m.

INSTITUTE OF METALS

Mon. to Fri., Sept. 16 *to* 20.—Forty-ninth Annual Autumn Meeting, 1957, to be held in Glasgow.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Wed., Sept. 18.—S. WALES CENTRE : Afternoon Visit to the Works of Pilkington Glass Company, Pontypool, Monmouthshire. ★ METROPOLITAN AREA : Afternoon Visit to the Motor Repair Centre of Shell-Mex and B.P., Ltd., Fulham, London, S.W.6.
Thurs., Oct. 3.—Royal Society of Arts, John Adam Street, Strand, London, W.C.2, Twelfth Annual General Meeting, 6.30 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Mon., Oct. 14.—N.E. BRANCH : Northern Architectural Association Hall, 6, Higham Place, Newcastle upon Tyne, "Building Structures," G. Gladstone, 7.15 p.m.

INSTITUTION OF ENGINEERS IN CHARGE

Wed., Oct. 9.—Caxton Hall, Caxton Street, Westminster, London, S.W.1, Forty-Fourth Annual General Meeting, 6.30 p.m.
Fri., Oct. 25.—Caxton Hall, Caxton Street, Westminster, London, S.W.1, Presidential Address, Sir Harold Roxbee Cox, 6.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

Fri., Sept. 20.—LONDON BRANCH : Institution of Civil Engineers, Great George Street, London, S.W.1, "Pavement Construction on Christmas Island," V. J. M. Smith and R. Airey, 5.30 p.m.
Tues., Oct. 1.—E. ANGLIA BRANCH : Assembly House, Norwich, "Ordnance Survey," E. P. J. Williams, 6.30 p.m.
Thurs., Oct. 3.—YORKSHIRE AND LINCOLNSHIRE BRANCH : Technical College, Lincoln, "Control in the Manufacture and Laying of Bituminous Materials," H. G. Barnes, 7 p.m.
Fri., Oct. 4.—LONDON BRANCH : Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "Construction of Soil Cement Roads and Road Bases in Holland," F. A. Van der Sluis, 5.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Wed., Sept. 25.—GENERAL MEETING : Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, Presidential Address, E. S. Cox, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Sat., Sept. 14.—SOUTHERN BRANCH : Whole-day visit to the Greenham Common Base of the United States Air Force, Newbury, Berks, 10 a.m.
Tues., Sept. 17.—N.W. GRADUATE SECTION : Engineers' Club, Albert Square, Manchester, Branch Chairman's Address, 7 p.m.
Wed., Sept. 18.—E. MIDLANDS BRANCH : Room C4, Engineering Building, Nottingham University, Joint Meeting with the E. Midlands Graduates Section, "Nuclear Reactors," M. D. Wood, 7.15 p.m. ★ S. GRADUATE SECTION : Visit to Harland and Wolff, Ltd., Southampton, 10.30 a.m.
Thurs., Sept. 19.—MIDLAND BRANCH : Summer Outing to B.I.C. Cables, Ltd., Southport, and Leyland Motors, Ltd., Leyland.
Fri., Sept. 20.—N.E. GRADUATE SECTION : Visit from Tyneside to Calder Hall Atomic Generating Station.
Sat., Sept. 21.—N.E. GRADUATE SECTION : Visit to the Furness Shipbuilding Company, Ltd., Haverton Hill, Co. Durham.
Tues., Sept. 24.—GRADUATES' SECTION COVENTRY : Leofric Hotel, Coventry, "Industry, the Institution and the Engineer of the Future," A. G. Booth, 7.30 p.m.
Wed., Sept. 25.—S. BRANCH : Royal Aircraft Establishment Technical College, Farnborough, "Some Engineering Problems in Connection with the Industrial Application of Nuclear Energy," Sir Claude Gibb, 7.30 p.m. ★ YORKSHIRE BRANCH : Royal Victoria Hotel, Sheffield, "The Work of the Standards Engineer in Industry," H. Stafford, 6.30 p.m.
Thurs., Sept. 26.—E. MIDLANDS GRADUATE SECTION : College of Art, Green Lane, Derby, Film Show, 7.15 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Wed., Sept. 18.—BIRMINGHAM SECTION : College of Technology, Gosta Green, Birmingham, 4, Film Evening, 7 p.m. ★ WOLVERHAMPTON GRADUATE SECTION : Wolverhampton and Staffs College of Technology, Wulfruna Street, Wolverhampton, "Nimonic Presswork," J. A. Grainger, 7.30 p.m.
Tues., Sept. 24.—OXFORD SECTION : Town Hall, Oxford, "Transfer Pressing," 7.30 p.m.
Wed., Sept. 25.—SHREWSBURY SECTION : Shrewsbury Technical College, Shrewsbury, "British Clock and Watch Production," R. Lenoir, 7.30 p.m.
Thurs., Sept. 26.—NORWICH SECTION : Norwich City College, Ipswich Road, Norwich, "S.G. Iron—A Versatile Engineering Metal," W. W. Braidwood, 7 p.m.
Fri., Sept. 27.—LEICESTER SECTION : Grand Hotel, Leicester, "Work Measurement and Its Uses for Management," W. Hewett, 7 p.m.
Fri., Oct. 4.—Dorchester Hotel, Park Lane, London, W.1, Annual Dinner.

IRON AND STEEL INSTITUTE

Tues., Sept. 24.—4, Grosvenor Gardens, London, S.W.1, Autumn General Meeting, 10.45 a.m., to be followed by a Lecture at the Royal Institution, Albemarle Street, London, W.1, "The Future Engineering Development of the Gas-Cooled Nuclear Reactor," J. M. Kay, 6 p.m.
Wed. and Thurs., Sept. 25 *and* 26.—IRON AND STEEL ENGINEERS' GROUP : Church House, Westminster, London, S.W.1, "Air Pollution in the Iron and Steel Industry."

MANCHESTER GEOLOGICAL AND MINING SOCIETY

Thurs., Oct. 10.—Mining and Technical College, Wigan, Annual General Meeting, 3.30 p.m.

ROYAL AERONAUTICAL SOCIETY

To-day, Sept. 13.—FORT-FIFTH WILBUR WRIGHT MEMORIAL LECTURE : Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1, "Advanced Education and Academic Research in Aeronautics," Clark B. Millikan, 6 p.m.

ROYAL SOCIETY OF HEALTH

Thurs., Oct. 3.—WEYMOUTH SESSIONAL MEETING : St. John Hall, Westway Road, Weymouth, "Public Health Aspects of Atomic Energy," Katharine Williams, 10.30 a.m.

SOCIETY FOR WATER TREATMENT AND EXAMINATION

Wed. to Fri., Oct. 2 *to* 4.—Palace Hotel, Southend-on-Sea, Autumn Meeting.

SOUTH WALES INSTITUTE OF ENGINEERS

Tues. and Wed., Oct. 29 *and* 30.—Park Place, Cardiff, Centenary Celebrations.

Advanced Engineering Courses

Detail Design of Welded Structural Steelwork. Organised by the Institute of Welding, to be held at Blackfriars House, Parsonage Manchester, 3. A course of ten lectures commencing on Wednesday, October 2, at 6 p.m. to 8 p.m. Fee £3 3s.

Scientific Principles of Fuel Technology. SIR JOHN CASS COLLEGE, Jewry Street, Aldgate, London, E.C.3. Course commencing September 26, Thursday evenings, 6.30 to 7.45. Fee £1 12s.

Structural Analysis by Influence Coefficients. BATTERSEA COLLEGE OF TECHNOLOGY, Department of Civil and Mechanical Engineering, Battersea Park Road, London, S.W.11. A course of ten lectures commencing October 2, Wednesday evenings, 6.45 to 9. Fee £1.

Structural Design in Aluminium. BATTERSEA COLLEGE OF TECHNOLOGY, Department of Civil and Mechanical Engineering, Battersea Park Road, London, S.W.11. A course of eight lectures commencing October 3, Thursday evenings, 7 to 9. Fee £1.

Analogue Methods for Solving Problems in Fluid Mechanics. UNIVERSITY OF LIVERPOOL, Department of Mechanical Engineering, Brownlow Hill, Liverpool. A course of ten lectures commencing October 8, Tuesday evenings, 5.30 to 7. Fee £2 12s. 6d.

The Oxidation of Hydrocarbons. UNIVERSITY OF LIVERPOOL, Department of Extra-Mural Studies, Technical College, Borough Road, Birkenhead. A course of ten lectures commencing October 8, Tuesday evenings, 6.15 to 7.45. Fee £2 2s.